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ELECTRIC TRACTION.

WE cannot help expressing surprise at the exceeding slowness with which the idea of electric street locomotion wins its way into the minds of capitalists in this country. There have for the last couple of years or so been abundant opportunities for acquiring information upon the subject: the broad facts regarding the great economical and practical possibilities of electrical modes of traction have been from time to time set forth in the press, and it may be assumed that the several companies formed with the express object of bringing electric railways into operation have neglected few opportunities of publishing their propaganda; yet we are in a state of almost complete stagnation in regard to what should be one of the most remunerative and practically successful enterprises of this generation. How to account for this hesitancy in taking up so promising a concern we know not. It is idle to suppose that the scare which frightened investors so long from things electrical is still sufficiently strong to act prejudicially upon electric locomotion, for in other and far more dubious branches of electrical industry there is no lack of activity, apparently no lack of people willing to invest. We have referred to capitalists as those of whom it might have been expected that they would display some interest and activity in this matter. It may be urged that it would be more reasonable to expect tramway directors to take the initiative in adopting electricity in place of horses. Well, we confess we see no reason why they should not, almost to a man, resolve upon the early substitution of the inanimate for the living motive power; but they have a groove already provided in which they run with moderate success, and they are either too indolent or too fearful to run risks by inaugurating sweeping changes of this nature. Our reference to capitalists is induced by the feeling that if a few of that enviable order were to combine and start one or two or more totally new tramlines in suitable localities, employing electricity as the motive power, it would have much greater effect in demonstrating the applicability and economy of electric motors for tramway purposes than the mere running of isolated cars here and there, and in alternation with the horse-drawn vehicles. The Stratford-Manor Park experiments (they are happily more than experiments now) have done a very great deal of good in impressing tramway people with the practicability of the thing; but its financial success, however certain it may be, is not borne in upon the mind by the mere observance of crowded cars, although evidence is presumptively in its favour, and as yet no details of the cost of working have been made public. There have been peculiarly trying difficulties upon this line, difficulties of a nature which would possibly never occur in a future venture, and these have added greatly to the initial expenses of the undertaking. Yet we have no doubt that a statement could be produced, covering the period during which the Elieson locomotives have been in operation, which would compare favourably with the most economically worked horse or steam-propelled system in the country. As the enterprise takes shape the working cost will naturally diminish, and it is confidently predicted that in future it will be reduced to one-half of the working cost with horses. We have no intention here of going into calculations, or of giving figures of any kind. We have already given information of this character in our columns, and to any enquirer shall be glad to give the references. Our present desire and motive is to attract the attention of those who wish to be instrumental in opening out on a large scale an enterprise and an industry in this country which shall be at the same time strikingly novel, practically successful, and highly remunerative to themselves. Capitalists, you have taken your cue from America often enough when the promises have not been so definite, nor the evidences so clear, as they are now. Follow the example once more of your American brethren in this matter of tramway traction, and, whilst you work for industrial progress and not for personal aggrandisement through the Stock Market, we venture to predict that you will never regret your boldness. Another column contains an account of the reception of the Elieson car in Buffalo. This is but one more of many illustrations of the enthusiasm which prevails in the States in favour of electricity for rapid street transit.

WE publish a letter from Messrs. Smith and Son for two reasons: first, because we are asked so to do; and secondly, for the edification of an esteemed contemporary, the energy and enthusiasm of whose present editor knows no bounds. We always pride ourselves upon being the very counterpart of little George Washington, notwithstanding the lack of cherry trees on which to wield our axe in Paternoster Row; nevertheless, we find that our infallibility is doubted in a quarter where we least expected such scepticism. Our friend the enemy sympathises with the wrath and indignation to which we gave vent a fortnight since when commenting upon the Water Primary Battery Company; our proposition to form an association for the abolition of primary batteries did not meet with serious opposition; yet, from information which he has received, our estimable opponent comes to the conclusion that we have been misled. Lest there be any misunderstanding as to the source of knowledge to which the seeker after truth hied him, we are in the position to inform our readers that it was no other than the redoubtable M. Paul Raoul de Faucheux D'Humy himself. Now we can very well believe, or at least try to delude ourselves into the belief, that this eminent scientist is so absorbed in the rejuvenated "Maiche" cell as to be utterly oblivious of the doings of his com-

mercial supporters; we feel, therefore, all the more sorely grieved that our contemporary did not cross-question the "eminent one" more closely, or apply to us for a private peep into the prospectus of the company, for such guilelessness is worthy of the nature of a "heathen Chinee." However, "all's well that ends well," and the laugh is on our side, but this little incident may perhaps be the means of checking the exuberant verbosity which at present seems to inflate the columns of an old-established and eminently respectable journal.

WE have before us copies of rules issued by the Law Fire Office and the Guardian Assurance Company. In addition to these there are the "Phœnix" rules and those of the Society of Telegraph-Engineers and Electricians. The first-mentioned consist of 21 items only, the longest containing only 24 words. The Guardian rules are more voluminious, and in addition two useful tables of the carrying capacity of conductors are given. But we cannot see at a casual glance that there is anything contained in these instructions which is not amply dealt with in the compilation of Mr. Musgrave. Heaphy; in fact, the "Phœnix" rules embody all and more than those of the companies to which we have referred. Reasons are conceivable, however, why each insurance company should desire to possess a code of rules of its own, but what possible need there was for the further addition by the Society of Telegraph Engineers, we are unable to see. Surely the committee does not suppose that an office with rules of its own would set them aside for those of the Society! A man desiring to insure can not choose for himself under what rules he will be insured; indeed, it often happens that he has no choice even as to the office to which he shall go. Perhaps, however, the Society's rules are designed, not to supersede or contend with those of the company's, but with the view of affording information and assistance to those who adopt the electric light, quite apart from the question of insurance.

THE year 1888 is not to be without its Exhibition. The Irish Exhibition in London is to be opened at Olympia on June 4th, and those Londoners who have not had the opportunity of paying political visits to the sister isle, may now learn something of the condition of the "distressful country" without stirring far from their own doors—may possibly gain more real knowledge than would have been theirs had they actually crossed St. George's Channel, for the Exhibition is to know neither politics, religion, nor class. It has a striking list of sponsors—distinguished representative men only found acting together when some great occasion of non-party significance calls them to duty. Ireland possesses great natural resources and important industries, and a comprehensive display of what she can produce or manufacture will not only be an object lesson of the greatest interest to the people of Great Britain, but will do much to assist the revival of trade in Ireland. With the view of giving the Irish artizan the same opportunity for exhibiting the product of his skill as the large manufacturer, the Executive Council has determined to make no charge for the space occupied in the Exhibition, except in special cases. The Exhibition will remain open until the end of October, and the whole of the vast space at Olympia will be utilised. Among the special features will be a representation of an Irish village, with the veritable peasants at work upon their cottage industries—the dyeing of yarn, making lace, knitting, &c. This should be as interesting as any of the series of exhibitions which have drawn London, England indeed, Kensington-wards during the past half-dozen years. The profits—we hope they will be large—are to be given in aid of Irish technical and commercial schools.

ONE of our weekly contemporaries not only supplies its readers with electrical literature, but occasionally devotes a considerable portion of its space to providing them with what it considers sound doctrine in religion and ethics. An opportunity of displaying the extent of his Biblical knowledge is never missed by the enterprising editor; but we doubt if his dissertations on the evils of Sabbath-breaking will quite suit the majority of his readers.

THE article in our other pages on the use of electricity for actuating the pumping plant in mines is very interesting. Messrs. Immisch seem to possess a wonderful capacity for overcoming all obstacles which are met with in such operations; indeed, the firm may be considered the only one in the field for this special class of work, which bids fair to speedily develop into large proportions.

THE programme for the next Electro-Harmonic Concert on the 6th proximo is before us. A better, we think, has never been submitted to a smoking concert audience, and there is little doubt that the members of the society will attend in their usual large numbers to witness and assist in a fitting close to a second successful season.

A MONTH or two ago we described the immense magnet made by Major King with two large Rodman guns, and expressed the hope that further experiments than had at that time been made would be undertaken with the view of determining the power of the monster. We learn that some very interesting experiments have since been carried out. From the description which has reached us, we should say that they were more interesting than useful. A crowbar which was applied to the magnet required the combined force of four strong men to tear it away. A handful of tacks thrown in the opposite direction immediately flew back and attached themselves to the magnet. Several 15-inch cannon balls, solid, and as much as a strong man could lift, were held suspended in the air, one under the other. The most amusing experiment was made with a sledge hammer. When one tried to wield it in a direction opposite to the magnet, he felt as though he were trying to hit a blow with a long feather in a gale of wind. Another curious test was made with a number of carpenter's spikes. A spike was put lengthwise on the end of the magnet, then another spike was attached to the first and so on, until a line of them stood straight out from the magnet at least four feet in length. This is all very pretty and entertaining, but we should like to hear of experimental tests and measurements which would give some definite knowledge regarding the capabilities of so large an electro-magnet.

COPPER has been a great deal before the public latterly, and it may be of interest to give a few statistics of the world's production of the commodity. Messrs. Merton & Co. have just issued their annual compilation on the subject, from which it is to be gathered that

from two sources the supply has largely increased. The United States mines produced 79,109 tons of fine copper in 1887, compared with 69,805 tons in 1886, 74,050 tons in 1885, 64,700 tons in 1883, and 51,570 tons in 1882. The production last year was nearly three and a half times larger than the production in 1879. In Spain and Portugal the output of 54,056 tons last year compares with 49,653 tons in the preceding year, 47,873 tons in 1885, 46,415 tons in 1884, 44,607 tons in 1883, and 39,560 tons in 1882. The Chilian production has, however, been falling off steadily since 1882. In that year the amount produced was 42,909 tons, in 1883 it was 41,099 tons, in 1884 41,648 tons, in 1885 38,500 tons, in 1886 35,025 tons, and last year 29,150 tons. Adding the figures of these three principal sources of supply together, it will be seen that the aggregate last year was 162,314 tons, against 153,463 tons in the preceding year, or an increase of 8,851 tons in the past year. The increase since the close of 1887 has, of course, been on a very much larger scale, and if production is continued at the present rate for the rest of the year the figures at the close will not be far short of 200,000, if, indeed, it does not exceed that figure. The value of the copper imported into England from the States in the last two months was £282,022 against £7,350 only in the corresponding months of last year. There seems every prospect of the tactics of the Ring receiving a severe check shortly. The output of copper is increasing largely in various quarters over which the French financiers have little control, and a downward run in prices may be anticipated.

WHO would have prophesied a couple of years ago that Judson's would this year pay no dividend? Few, we imagine. When the business was turned into a limited liability concern a prosperous future—that is to say, a big dividend—was regarded as assured. Yet, in the course of one year business failed, new speculations which looked promising turned out failures, a loss was sustained, and there were not wanting excitable shareholders at the meeting last week to cry, "Wind up!" Curiously enough, the electrical business, which was supposed at the outset to be rather a doubtful thing to touch, has been comparatively the best; at least, according to the directors, the loss in that branch has been less than in the others, and it holds out brighter prospects for the future. Competition, which has become severe in several articles in which Judson's formerly held almost a monopoly, is alleged to be at the bottom of the falling off in revenue. But the good name earned by the firm in times past should stand it in good stead, and there is no reason why another turn in the tide should not once more set the business well afloat.

THE action of the Edinburgh Town Council in joining with the similar body in the adjoining town of Leith to acquire the works and business of the local gas companies has excited much hostile feeling in Modern Athens. A large section of the ratepayers have protested against—or rather petitioned against—the purchase of the gas works, upon the ground that it would be unwise of the corporations to become proprietors whilst there was such a dangerous rival to gas as an illuminant springing up in the shape of the electric light. The Council has disregarded the petition, and stands committed, by resolution, to the policy of purchasing and working the gas business. But the sages find it not quite so easy as it at first seemed to become possessed of gas undertakings. They have, in conjunction with their *confrères* at Leith, promoted a Bill in Parliament embodying an agreement into which they have entered with the Edinburgh Gas Light Company, and in which they further seek powers to purchase, on certain terms, the undertaking of the Edinburgh and Leith Company. This latter body, not approving of the terms, intends to oppose the Bill; and the ratepayers whose petition was set aside have also resolved upon active opposition; moreover, the Edinburgh and Leith Company is propounding a Bill of its own, which the Edinburgh and Leith Town Councils will in their turn oppose. Whatever may be the ultimate result, it is pretty evident that it will not be reached except at heavy cost to the ratepayers. It might or might not be beneficial and remunerative to the City to become its own gas producer; it cannot be otherwise than enormously costly for the Council to persevere in a necessarily long Parliamentary fight with those with whom it finds itself in conflict; and weighing the two considerations against each other, we think the combined Corporations will be upon the safer side in withdrawing from their difficult position, annulling (as they have the power to do) their agreement with the Edinburgh Company, and confining their endeavours to securing the best possible arrangement for the future supply of gas, or light in any form, to their respective towns.

THE importance of the block system on railways is so manifest that it seems strange to read that any company is as yet unprovided with it. Yet we are told that the directors of the North British Railway Company have only just determined to adopt the system over the whole of their lines; it has, apparently, been in operation over some parts of their route for some time. Recommendations to complete the protection of their own property and their passengers' lives by fully adopting the block has been frequently urged upon the company in Board of Trade reports, and while it is satisfactory to learn that the company is at length showing its appreciation of the situation by devoting £10,000 to the purpose, blame for the long delay cannot be altogether withheld.

HOW does the Institute of Medical Electricity progress? We have heard but little of it since the issue of the prospectus, and should be glad to know whether it has been well supported or not. We do not care to see what should be a worthy institution hiding its light under a bushel.

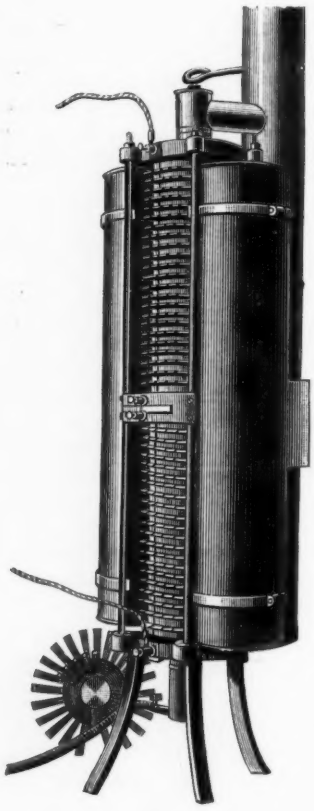
TO the correspondent who wrote a week or so ago enquiring respecting the patent for the method of armature-winding invented by Herr von Hefner-Alteneck we have to say that the patent to which we believe he refers was taken out in 1873, and has therefore expired.

THE rapid increase in the number of submarine cable beacons is becoming a serious consideration, and navigators are not particularly well pleased with the multiplication of their difficulties in some waters. The Italian Government has been considerably developing its submarine communications of late, and the chief of our Hydrogaphers' Department at the Admiralty has received notice of the placing of no less than thirty cable beacons at various parts of the Italian coast, nearly every one of which has to be noted by captains of ships in one of the Admiralty charts of Italian waters.

E. RAUB'S NEW THERMO-ELECTRIC BATTERY.

By G. BETZ.

FOR years it has been the endeavour of electro-technicists in constructing electric generators to devise appliances which should not merely surpass earlier models in simplicity but should also be capable of converting any given power into electric energy in the cheapest manner and which should, in short, perfectly meet all the demands made both by specialists and by the outside public. It is certain that in the future the direct transformation of heat into electricity will afford the possibility of generating electric energy in the simplest, cheapest and most practical manner. Hence it is desirable and advantageous that as much attention should be given to the improvement of thermo-electric batteries as there has recently been bestowed upon dynamos.



An essential advance in this sphere has recently been effected by a new construction of a thermo battery devised by E. Raub, of Berlin. It is of prominent importance since in it all the short-comings of the old thermo batteries have been removed and since it is applicable at a small working cost for many technical purposes, especially for electrolytic uses, and since the first outlay is very low.

As will be seen from the accompanying figure, the battery consists of two main portions: 1, the annular elements and the heating channel which they form; and 2, the refrigerator, which is applied separately. The circle shown in the figure behind the tripod represents a single element; the positive electrode is formed by a ring of an alloy cast around a copper heating ring, thus effecting a very durable and intimate metallic connection. Externally it is enclosed in a second ring of copper, with refrigerating projections arranged radially. The negative metal is soldered to the heating ring in thin plates and in such a manner that during working, local currents at the points of contact are entirely avoided. After the elements have been built up, the negative metal of each is soldered to the refrigerating projections of the following element.

A number of similar thermo-elements, of any desired size, are insulated from each other by means of a fire-proof material and pressed together between two cast iron plates in such a manner that the several rings are superimposed concentrically, forming in this manner a firm, safe hollow cylinder which serves as the heating chamber. The heating is effected by means of any convenient source. For smaller apparatus like that shown in the figure a ring-shaped Bunsen gas burner is sufficient. For larger batteries a coal or coke fire is required. The flame of the Bunsen burner, screwed on to the lower end of the heating cylinder comes in intimate contact with the heating rings of all the elements, and takes up its supply of oxygen within the conical flame. The heat is distributed equally to the elements by means of a slender cone fixed to the cover of the heating chamber and projecting into it. It then passes through a transverse channel into a wide stove pipe closed below and screwed into the supporting tripod and connected with a chimney having a good draught. The hot air ascending in the chimney draws fresh air into air pipes fixed below the point where the heating chamber vents into the main pipe so that the external points of contact of the annular elements are kept cool by the draught. A valve is introduced for the regulation of the latter.

Great economy in working is effected by the application of annular thermo-elements in combination with this forcible introduction of air, which admits of the greatest possible utilisation of the heat and the production of the greatest possible differences of temperature. Collateral advantages are rapidity and ease in starting work and a minimum requirement of space, since batteries to be heated by gas may be mounted upon a bracket. As valuable features must be mentioned the durability and firmness of the separate elements, as also the possibility of removing damaged rings either for repairs or for the substitution of new ones which may be procured singly from the makers.

The three smallest models to be heated with gas and suitable for the electrolytic production of metals, for galvanoplastie, &c., consume hourly 300, 500, and 900 litres of gas (or about 11, 18 and 30 cubic feet) having strengths of current of 10, 20 and 40 ampères with an electromotive force of 3 volts. For an hourly consumption of 1 cubic metre these batteries give a useful effect of 80 volt-ampères, whilst those of former constructions yielded at most 27.

THE CONSTRUCTION OF AERIAL TELEGRAPHS.

Staying.

IN our recent article on snowstorms we commented strongly upon the necessity of staying the poles well, in order to meet, to some extent, the effects of accumulation of snow upon the wires. When snow gathers upon the wires their interruption is reduced practically to a certainty, for the weight of congealed snow or ice is, of itself, where the wires are at all reduced in gauge, usually sufficient to break the wire, and where the storm is accompanied by wind the enormously increased surface exposed to its force is sufficient to test to its utmost the constructive powers of the engineer, working within the narrow limits under which the construction of aerial telegraphs is usually effected.

The article referred to has produced an appeal for further observations upon the subject of staying. Desirous in all cases of meeting the wishes of our correspondents, we have much pleasure in returning to the subject, and we publish in our other columns data by which the strains of overhead wires, together with the stress on a given strut or stay, as also the direction of the strut or stay to meet certain strains, may be calculated. For this data we are indebted to the late Mr. Robert Sabine, who went very fully into the subject,

embodying the results of his investigations and calculations in a short paper communicated to the Society of Telegraph Engineers, from the Journal of which Society we extract the data furnished.

We are quite in accord with our correspondent, "Celt," that very much of the work dealt with in the construction of aerial lines of telegraph is carried out by "rule of thumb," and we hardly see how this is to be avoided in many instances. Take, for instance, the angle at which a stay is required to be placed in order to meet the stress thrown upon a pole, the wires upon which form an angle with the pole. If the stress is equal on either side—*i.e.*, the number of wires, the gauge, the span, the degree of tautness, all the same—conditions hardly possible to be realised—we know very well that the stay or strut should be so fixed as to intersect midway the angle formed by the wires; but how many of the class of men to whom is usually entrusted the construction of lines of telegraph are there who would even determine this accurately? If, then, this is so with a plain, straightforward case, such as is instanced, how would the difficulty be met where the conditions of the stress on either side are of a complex character? Those who build telegraphs know full well how difficult it is to secure a perfectly straight route; angles and sinuosities are the characteristics of the construction: they are unavoidable. Were we to meet this by placing men upon the ground possessing the necessary mathematical knowledge to enable them to lay down the position which each stay should occupy, it is clear that every addition made to the line of wires would involve—inasmuch as it would again alter in every case except that in which the strain on either side was equal, and that of the wire to be added was also equal—fresh calculations, and a readjustment of the angle at which the stay or strut was originally placed. Accuracy in these matters is no doubt desirable, but, as will be observed, this is somewhat difficult of attainment. As a rule, a line of telegraph is not complete in its first construction; a line of poles and so many wires are erected, and provision made for other wires to follow. If it were possible to build the line mathematically correct in the first instance, subsequent additions and alterations would soon derange the accuracy first obtained. Our observations, so far, have been devoted to the direction of the stay; but if we consider the question further, in the direction of the holding power of the stay, here again we shall find that only under exceptional circumstances have we a sure basis upon which to make our calculations. Where the pole and the stay or strut are fixed to or upon a rigid substance the data is definite, and it is only necessary to consider the strength of the pole and stay or strut in relation to the strain and weight of the wires. But in the majority of instances lines of telegraph are not so fortunately placed. Poles and stays have to be planted in the soil, by the roadside; on the slopes or in the cuttings of railways; at times in a hard, and at others in a soft and yielding soil; but under no circumstances in a rigid and unyielding substance, such as is afforded by a substantial building. It is a known fact that with well made lines, under exceptional circumstances and great stress of weather poles have actually been forced further into the ground by the pressure thrown upon them, the holding power of the stay acting as a fulcrum. In such cases it is probable both the stay and the pole suffer. The stay block is loosened, but its holding power is such that it cannot draw sufficiently to allow the pole to go over. The stay wire does not give, and hence arises the tendency to thrust the pole into the ground. It is not probable this would arise with a well-stayed pole planted in chalk or rock; but this is a condition seldom obtained. It thus becomes necessary when providing for a heavily-wired line to allow a sufficient margin to meet to some extent, if not fully, the varying conditions which may be looked for. This can only be met by using stay-blocks affording ample surface to resist the strain which may be thrown upon them; and by regulating the depth at which they are placed beneath the surface to the nature of the soil.

Another factor for consideration is the strength of the staying wire to be employed. Originally, and we are not sure it is not with some the practice still, old, and seconds wire was employed to form the stay. Stay rods are now almost invariably employed. These rods are provided with an adjustable loop at one end, so that when the stay becomes slack it can be screwed up; and from the loop stay wires are carried to the pole. To employ old, or even seconds wire for this purpose is a mistake. The stability of a line depends upon the rigidity of its stays. It is not possible to apply stays comprising more than one wire by hand, so that each wire may take its proper proportion of the strain. New wire should in all cases be used, and this wire should be of a special character, possessing great tensile strength and very little elongation. No. 8 Gauge is the best, and it can be drawn to any degree of ductility, and to bear a strain of fully 1,800 lbs. For staying purposes it should possess as little elongation as possible. It should be stranded by machinery. Three, five, and seven strands will probably meet all requirements. The three strand for light lines, five strand for heavy lines, and the seven strand for terminal work, or points where the strain is unusually severe. The "lay" should not be too short, or it will make the wire stubborn for handling. A one-foot lay—*i.e.*, each wire should pass around the rest forming the strand in that space—is a very convenient form.

In fixing stays in the ground regard should be had to the future. If the line is to be regarded as a permanent one, economy will attend the employment of good, sound, durable stay blocks. Creosoted timber is the best thing. Each block should present a flat surface to the soil against which it is drawn by the strain. For heavily wired lines these blocks should present a surface of from 300 to 350 square inches. They should be well fixed, the hole undercut as explained in "Preece and Sivewrights Telegraphy," so as to get a bearing against the solid earth; and the rod should be arranged in a direct line with the point at which the stay is to be attached to the pole. This point, it has been argued, should be the centre of the strain cast upon the pole by the wires it has to carry. Probably it ought to be somewhat higher, and, in practice, good staying is always so arranged. Here, again, we find the number of wires a varying factor; so, in fixing the stay, we must have regard to the number of wires the pole will have to accommodate. Between the third and fourth arm is probably, all points considered, the best position.

The spread, or the angle which the stay should form with the pole, is another consideration. The most efficient position would be that which placed it at right angles to the pole; but this is seldom obtainable. The next most efficient is that nearest to this condition, from which we gather that the greater the spread of the stay, the greater the holding power. On road lines there is little room for staying, but on railways the slopes and spare land skirting the rails often affords good scope for doing so.

The depth at which stay blocks should be fixed in the soil will, as previously suggested, vary with the nature of the soil, and the strain likely to be thrown upon them. It is not well to sink them less, for ordinary staying, than 4 feet, nor will it often be necessary to go beyond 5 feet, except for terminal stays, when each rod should be planted fully 6 feet. Good punning, when each block is fixed, is a point we need hardly impress upon the practical engineer.

The tables which we insert herewith, p. 337, will no doubt be useful in enabling us to determine what is necessary where we have definite and permanent quantities to consider, but it will be readily understood from what we have said that it is seldom these quantities are permanent, and it is therefore necessary that in giving them effect we should bear in mind the changes which are likely to arise—additional wires, alterations in route, deterioration of material, &c. Combining theory with experience, although "rule of thumb" will enter to some extent, we may hope to arrive at a fairly stable condition of things.

PUTTING UP INTERNAL WORK.

By G. L. ADDENBROOKE.

SUPPOSING that the sizes of the conductors and their insulation are settled, it remains to put them up. Now there are three ways of doing this.

They may be stapled a short distance apart along walls and ceilings without further protection, which was the early method of doing the work. Where wires cross deep mouldings, and for some other purposes, and for rough work, this method is still used, but it is not very sightly, and there is a difficulty in getting staples to hold securely in plaster.

For these and other reasons, and partly at the instance of the fire insurance companies, this method has generally been given up, and the use of wood casing for carrying conductors is now all but universal.

There are many things to recommend wood casing; it is moderately cheap, neat if carefully put up and the joints nicely made, it is of itself a good insulator, while with some little contrivance and attention it can usually be made to accord very well with existing fittings of furnished houses. If carelessly or clumsily put up, however, there are few things which are worse eyesores. It is hardly too much to say that nothing detracts more from the appearance of a nicely decorated house than badly designed casing with rough mitres at the corners and lids irregularly put on, run up and along walls in conspicuous places and with little regard for existing decorations. A good deal of such work has been done, and I am afraid will still continue to be until the public becomes better educated, and is better able to discriminate for itself between good and bad work of this character.

The proper people to put up casing, to take up floors, to cut holes through woodwork, mouldings and walls are carpenters and plasterers; the actual amount of work in wiring after all this is done is comparatively small, and after it has once been set out, does not demand great skill for its accomplishment. A set of men for wiring purposes should, I think, be chosen in about the following proportion, they of course being varied to meet particular requirements. An intelligent foreman, on whose taste, ingenuity and readiness of resource a great deal depends, three carpenters, a plasterer capable of touching up mouldings, making good plaster broken away in plugging, cutting neatly through walls, and doing a little papering and painting as may be required.

A wireman to run the wires in the casing, make joints and put up cut-outs, switches and fittings. A set of men like this, with a boy to fetch and carry for them, all handy and not above helping each other, even if it is a little bit out of the ordinary groove of their particular trade, will quickly and satisfactorily get through a large amount of work if they can go straight ahead. But this is dependent on the work being set out well in advance, and their not being kept waiting to know how they are to proceed. Perhaps in nothing more than installation work is preliminary care and arrangement better repaid, both by the great economy of labour it effects and the saving of trouble to the householder. Wiring does cause a considerable turn out in a house, and when once a householder has made up his mind the sooner the work is begun and the quicker it is completed the more satisfactory is the result likely to be to all parties.

When wires are to be put in new houses not yet finished there is an alternative plan to the use of wood casing, and I think in most instances a preferable one, and that is the employment of conductors enclosed in lead tubing. It is well, by a rib on the outside or some distinguishing mark to show the difference between conductor and water or gas pipes, but with this proviso, leads can be taken about a house with great facility, and they can be permanently embedded in the plaster of the walls in places where it would be difficult to make a sightly job otherwise. The practice of laying conductors in lead pipes is gaining ground in America, and it appears to be giving great satisfaction. From some personal experience in the use of lead-coverned conductors myself, I can vouch for their good qualities. As I have said before, the bugbear of the electrical engineer in distributing the current is *moisture*, and as nothing retains water better than lead pipe, or lasts longer, so we may expect that it will be equally efficient in keeping water out. The lead-covered conductor has this advantage over water pipes, that if there is a good stout braid between the conductor and the lead covering, besides what other insulation may be deemed necessary, it is practically impossible for the lead to come in contact with the conductor, and the lead itself being well supported inside does not suffer from pressure or weight applied anywhere on the outside as much as water or gas pipes do. Such a lead-covered conductor can hardly collapse.

As lead pipes under all ordinary conditions will last without deteriorating for an indefinite period there is no reason to expect that any limit could be put on the life of lead covered conductors. It may be asked if, when using alternating currents, the inductive action on the lead sheath would not be prejudicial if it made earth or was in contact in two places with another conductor of any kind. Some slight loss on this account must of course take place, but it is so small that it is of no practical moment.

In the arrangement of conductors for internal work there are two different plans which may be followed. One is to run from the point of entrance of the supply mains a pair of large mains through the house, taking leads from them where required in different directions like the branches of a tree. The other is to start with several independent circuits from the supply mains, running them together as far as their way lies in the same direction and then turning each circuit off in its appointed direction.

The second system is necessarily more expensive than the first and takes up more room, and although it is sometimes handy to have the main cut-outs of all the circuits in one place, yet I think in the majority of private houses it is quite unnecessary. In public buildings, however, it is often an advantage, frequently a necessity, to bring together in one place all the cut-outs and switches for the different circuits.

We now come to the much mixed question of "cut-outs." Cut-outs may be conveniently divided into two classes—cut-outs for safety, cut-outs for convenience.

In dealing with gas, people are content with one cut-out where the main enters the house, and that not an automatic one. If anything goes wrong with gas, prudent people turn it off at the main and go without the light until the fault is rectified. It is to the advantage of electricity that there is a simple automatic cut-out by which the effects of faults can be partially localised.

For safety a good general rule is that a cut-out should not protect so many lights that the small leads to any one of them would become seriously heated before the fuse went. This is a rule which applies to fittings and places where the lights are fixed. Where flexible cords are used a fuse should be fitted in each rose where the cord is joined to the leads. Flexible cords are, from their nature, more liable to accident than conductors kept apart and in fixed positions, and therefore they require more protection. Further, if several cords are protected by one cut-out, and a short circuit occurs, it is often a matter of difficulty to find out where the fault is.

On the rival merits of the different patterns of cut-outs I do not propose to say anything, as most of the patterns act well enough if they are properly made—and a great deal has been said on this subject already—but I should like to direct the attention of manufacturers and others to the forms of the cut-outs, or rather the cases in which they are contained. Cut-outs frequently have to be put in conspicuous places, and it is always better that they should not be hid away in out of the way corners. But if they are large and unsightly, and project far, or assume the shape of tooth powder boxes (a very popular style), to see them dotted about

promiscuously certainly seriously detracts from the appearance of a building. Cut-outs should always conform to the general character of the casing they are used with, and they should be continuous with it and not be placed to one side or the other, or on the top, as they so frequently are at present. It is important with both switches and cut-outs that they should not be too small or the parts cramped together. If they are made in their general character to conform to the casing, without being offensively conspicuous, they can be made much larger than would otherwise be advisable.

As with cut-outs so with switches; there are many different patterns which will work satisfactorily, provided they are well made, but the prices of all these articles are cut so fine that it is advisable to keep a weather eye open for defects and hasty workmanship. The faults most likely to be met with in switches are, tendency with use to work loose, sticking or inefficiency of the make and brake arrangement, defective clearance when the switch is off, cramping of parts, holding-down screws in contact with metal carrying the current, and awkward and unsatisfactory arrangements for bringing the conductors to the terminals.

While wiring is being done a battery should be kept across the terminals of the main leads, and the current got out at the terminals of each lamp-holder in every fitting as the work proceeds. This is a simple precaution which often saves a lot of trouble and annoyance later on. Before the lamps are put in their places each main should be tested for earth, which can be done with a sensitive galvanometer previously calibrated with sufficient accuracy for the purpose. The lamps should then be put in and the whole circuit run, for, say half-an-hour, with the full current on. It is a good plan at the end of this time to take out the main fuses and make another test of the installation, which can be done in a few minutes, and which shows that the work has stood the current all right. Too much reliance should not, however, be placed on the comparative results of tests. They are a very useful precaution, but good workmanship, guided by an elementary knowledge of the flow and action of electric currents, is the main element of success in installation work.

A good deal has been said about rules for installation work. For the credit of electric lighting and electrical engineers, it is important that incompetent people should not undertake such work, and that indifferent work should not be done by anyone.

If anything goes wrong with gas fittings the gas-fitter is blamed, but if now anything goes wrong with the electric light fittings of a house it is usually scored down as so much against the system altogether; this must be so until the public gets better educated. Consequently everyone interested in the light has, so to speak, a vested interest in work done by other people, since it indirectly affects himself.

Still it would, I think, be unwise to go in for more restrictions than are really necessary. It is better, even at the risk of some failures, which are, after all, the foundation of experience, that things should be left to work themselves out upon the principle of the inevitable survival of the fittest than that by the promulgation of hard and fast sets of rules progress should be hampered.

In the early days of gas lighting a Commission of the Royal Society, deputed by the Government to examine into the safety of the new industry, seriously recommended that gasometers should never be made to hold more than 6,000 cubic feet, and that they should always be placed inside very strong buildings. They did this after the engineer in charge had knocked a hole in the side of the gasometer and applied a light to the issuing gas to convince them that their fears of an explosion were groundless.

Hotel Lighting in Edinburgh.—The electric light is being introduced into several of the hotels in Prince's Street, Edinburgh, by the Anglo-American Brush Electric Light Corporation.

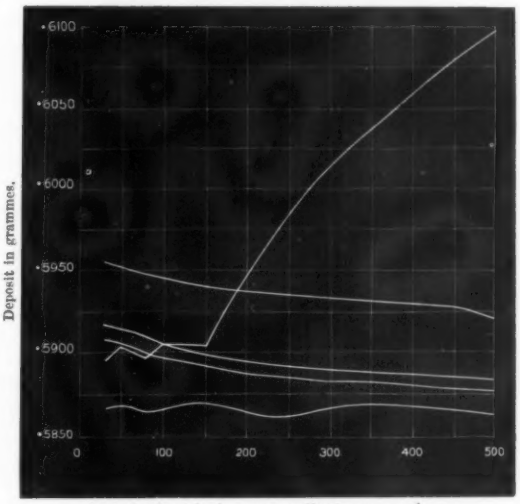
THE ELECTROLYSIS OF COPPER SULPHATE IN STANDARDISING ELECTRICAL INSTRUMENTS.*

(*Continued from page* 317.)

Size of Plates.

Loss plates should never have an area of less than 40 square cms. per ampère. If the area is much less than that the resistance of the cell becomes high and variable owing to the formation of copper oxide on the plate, and, if it be made very small, gas is given off at its surface, making it impossible to keep the current steady, and giving a result of no value for accurate standardising. The gain plates should never expose a surface of less that 20 square cms. per ampère. When too high a current density is used the deposit is not so adherent to the plate, and a portion may be lost in washing and drying. It is always best to use an area of from 50 to 100 square cms. per ampère, using the larger area for currents which are intended to run for some time. By doing so any little roughness round the edges is avoided, and in consequence plates are easier to dry.

As already mentioned at the beginning of the paper, the amount of copper deposited by a given current varies with the area of the plate exposed to the corrosive influence of the free acid in the solution of copper sulphate. This variation is not the same as it would be were no current running, in reality it is less, from which it would seem that the current exercised some protecting power. This subject has been very fully investigated in the Physical Laboratory of Glasgow University, as also the effect of temperature on the rate of loss, and the results of the experiments are shown in the table of curves No. II., and the two tables of numbers which I shall speak of presently.



CURVE I.

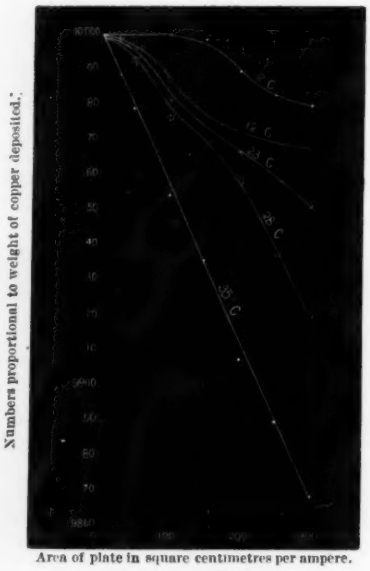
The experiments were made with 10 cells in series, all carefully insulated from each other, and each cell having a different area of gain plate, the extreme range being from about 30 to 500 square cms. per ampère. The solution used in all cases was 1·175 in density with 1 per cent. of H_2SO_4 added. From former experiments, described in Mr. Gray's paper, on electrolysis, before mentioned, no difference could be observed in the amount or appearance of deposits from solutions containing percentages of acid varying from ½ per cent. to 5 per cent. at a temperature of about 12° C., but owing to the very rapid consumption of the free acid in the solution at the higher temperatures, fresh solution was used each time.

The curves show the results obtained for different areas of cathode or gain plate, and each curve is for a different temperature between 2° C. and 35° C. It will be observed that they all converge rapidly towards the point of crossing which shows that the same deposit would be had at all temperatures were it only possible to use a small enough area of gain plate. The curves were produced to cross the line of ordinates, and the point of crossing was taken as 10,000, and the other points reduced to correspond, so as to render percentage corrections easy for different current densities. The ordinates are therefore numbers proportional to the weight of copper deposited in grammes, while the abscissæ are areas of gain plate in square centimetres per ampère.

The curve for 2° C. is the mean of three experiments, which were in very close agreement. It is rather curious that for a

* Paper read before the Physical Society of Glasgow University, January 27th, by Mr. A. W. Meikle, Thomson experimental scholar.

range of current density almost up to 130 square cms. per ampère there is no effect made by variations in the area of gain plates, but the same tendency is shown in the curves for 12° C., 23° C., and 28° C, although to a much smaller extent. The curve for 12° C. is the mean of a large number of experiments which were in very good agreement among themselves. It is the same curve which is shown as the mean curve in the first table, but on a different scale. The effect of temperature from 10° to 15° C., which is about the ordinary range of temperature in the Physical Laboratory of Glasgow University, is very small and may be neglected. Indeed with a gain plate of 50 sq. cms. per ampère, the total variations in the corrected equivalents for 12° and 28° C. is only about $\frac{1}{10}$th per cent. The curves for 23° C. and 28° C. are two single experiments, while the curve for 35° C. is the mean of two experiments which were in good agreement with each other. A glance at the curves will show how important the question of temperature becomes at the high points. In countries where 28° and 35° C. were normal temperatures, a very careful allowance would require to be made for any variation. Table No. I. gives the numbers from which the second table of curves is taken,



CURVE II.

and Table No. II. gives the corrected electro-chemical equivalents as calculated from these numbers for different current densities, from 1 ampère to 50 sq. cms. up to 1 ampère to 300 sq. cms.

TABLE I.

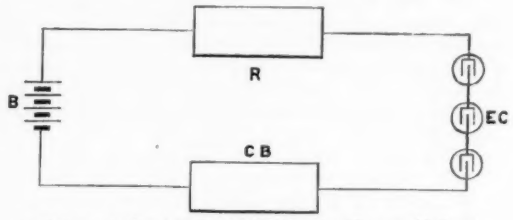
Area of cathode in square centimetres per ampère of current.	Temperature, 2° C.	Temperature, 12° C.	Temperature, 23° C.	Temperature, 28° C.	Temperature, 35° C.
50	10,000	9,996·4	9,995	9,993·5	9,980·5
100	10,000	9,987	9,983	9,979·5	9,958
150	9,998	9,979·5	9,974	9,969·6	9,935
200	9,990	9,973	9,966·6	9,957·5	9,912
250	9,984	9,970	9,959·5	9,939·3	9,890
300	9,980	9,968·5	9,952	9,920	9,868·5
400	...	9,961	...	...	...
500	...	9,949	...	...	...

TABLE II.

Area of cathode in square centimetres per ampère of current.	Temperature, 2° C.	Temperature, 12° C.	Temperature, 23° C.	Temperature, 28° C.	Temperature, 35° C.
50	·0003288	·0003287	·0003286	·0003286	·0003282
100	·0003288	·0003284	·0003283	·0003281	·0003274
150	·0003287	·0003281	·0003280	·0003278	·0003267
200	·0003285	·0003279	·0003277	·0003274	·0003259
250	·0003283	·0003278	·0003275	·0003268	·0003252
300	·0003282	·0003278	·0003272	·0003262	·0003245

Standardising Arrangements.

The arrangements for standardising consist, as shown in the diagrams, in joining in series a constant battery, the instrument to be standardised, the electrolytic cells, and a variable resistance. Care should always be taken to join the instrument directly on to the electrolytic cells, and have that portion of the circuit well insulated, so as to be sure that the instrument is recording the exact amount of current which is going through the cells.



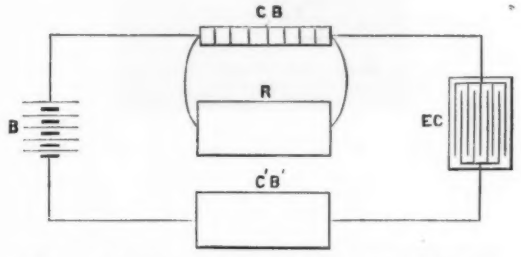
B, battery; R, rheostat; E C, electrolytic cells; C B, current balance.

FIG. 7.

The simplest form of arrangement is shown in fig. 7, and is suitable for currents up to 10 ampères. The variable resistance used in this case is one of Sir William Thomson's rheostats. For currents up to 1 ampère a high resistance rheostat of platinoid wire is used, and for currents above that point a large rheostat of stranded copper wire, the potential of the battery being first adjusted to suit the special case. With large currents beyond the carrying power of any rheostat, a conductivity bridge is put in circuit for the purpose of varying the current. This bridge consists of a number of platinoid U's of sufficient length not to heat much with any current which the potential of the battery can send through them. By dipping the two ends of these U's in two parallel mercury troughs any desired conductivity can be put into the circuit. Fig. 8 shows two of the large bridges, one of which is standing in the mercury troughs, while the other is standing on the insulated sides. The large bridges are kept apart by wooden distance-pieces, as shown in the figure, while the small ones are supported on strips of wood throughout their whole length, and are fitted with thick copper terminal pieces. The copper rheostat before mentioned is joined in parallel to this bridge, and the whole arrangement, as shown in fig. 9, simply takes the place of the rheostat in the former arrangement. We have found this last arrangement very useful for standardising instruments, as with the battery power at our disposal, any current up to 500 ampères can be had by continuous steps. The apparatus being arranged as stated above, trial plates, of the same

FIG. 8.

area as the gain plates to be used, are put into the electrolytic cell, and the current is adjusted to the required reading on the instrument. The circuit is then broken, the trial plates are replaced by the cleaned and weighed gain plates, and current is again made, the exact second being noted on an accurate timekeeper. The instrument should be found very nearly to record the desired reading, and should at once be adjusted by turning the rheostat, and by that means be kept steady during the experiment. Any error arising from the current not being at the proper strength on starting is very small. As a rule the current, when previously adjusted as above is, practically speaking, exactly correct when made for the standardising; but should it chance to be even so



B, battery; R, rheostat; C B, conductivity bridge; C' B', current balance; E C, electrolytic cell.

FIG. 9.

much as 5 per cent. wrong, an amount which with the precautions taken is entirely out of the question, it can easily be set right in at most 10 seconds with apparatus such as has been described, and the whole error on an experiment lasting for one hour would only be about $\frac{1}{10}$ per cent. The current should be run long enough for the deposit to be so great that any possible error in weighing or in starting or stopping the current is practically speaking eliminated. In breaking the current the exact second is again noted, and the plates quickly removed from the clips and placed in a glass vessel containing pure water with a few drops of $H_2 SO_4$ added to prevent oxidation. From this they are taken one at a time, dipped in pure water, then dried and weighed, as before described, in the process of cleaning with silver sand. The jaws of the clip are always opened before putting in or taking out the plates, so that there can be no error due to loss of weight by the friction of the plate with the spring contacts. The zero of the instrument is always carefully noted before and after the experiment.

Standardisings of Sir William Thomson's Standard Current Balances.

As showing the degree of accuracy which can be obtained by the electrolysis of copper sulphate, I shall briefly give the results obtained from the standardisings of Sir William Thomson's standard current balances, the constants for which have been determined by the methods I have described. There are in the physical laboratory at the present time seven of these balances whose measuring range is as follows:—

1. Hecto-ampère balance		range from	10	to	500	ampères.
2. Deca " "		" "	2	"	100	"
3. Ampère balance		" "	0·5	"	25	"
4. Deci-ampère balance	(*a*)	" "	1	"	50	deci-ampères.
5. " " "	(*b*)	" "	·5	"	25	" "
6. Centi-ampère balance	(*a*)	" "	1	"	50	centi-ampères.
7. " " "	(*b*)	" "	·5	"	25	" "

(1) The constant of the hecto was first found by electrolysis and the weights calculated from the result of the experimeuts. On being again checked by electrolysis on December 2nd, 1886, with its adjusted weights, instead of 100 ampères as indicated by the instrument the mean of two experiments gave a current value of 99·996 ampères.

(2) The deca-ampère balance was standardised by direct comparison with the hecto, and on being checked by electrolysis on February 15th, 1887, a result of 49·978 ampères was obtained against a current of 50 ampères read on the instrument. The latest comparison still shows the instrument to be in perfect agreement with the hecto. It has also been twice standardised by electrolysis at intervals of six months, which gave results respectively of $\frac{1}{20}$ per cent. and $\frac{1}{30}$ per cent. too low.

(3) The constant of the ampère balance was determined by electrolysis, and on afterwards being compared with the deca. it showed a variation from that instrument of $\frac{1}{60}$ per cent. When compared with the deci. the agreement was within $\frac{1}{100}$ per cent.

(4) The constant of deci-ampère balance (*a*) was twice determined by electrolysis which gave a difference of $\frac{1}{600}$ per cent. between the two standardisings. Its weights were taken by calculation from the results of these experiments, and on being again checked by electrolysis the result showed $\frac{1}{50}$ per cent. too large on a current of 4 ampères as read on the balances.

(5) Deci-ampère balance (*b*) was standardised by direct comparison with centi-ampère balance (*b*), and on being afterwards compared with deci-ampère balance (*a*) showed a variation from that instrument of less than $\frac{1}{100}$ per cent.

(6) The weights for centi-ampère balance (*a*) were determined by direct comparison with an old and now disused form of deci-ampère meter in June, 1887. Since that date it has been checked at intervals by four separate electrolysis experiments which gave results respectively of $\frac{1}{15}$ per cent., $\frac{1}{15}$ per cent,, $\frac{1}{17}$ per cent., and $\frac{1}{10}$ per cent. too large, which is very satisfactory when the small weight of the deposit is considered. Compared with deci-ampère balance (*b*) this instrument is in absolute agreement.

(7) The constant of centi-ampère balance (*b*) was determined by direct comparison with centi-ampère balance (*a*), from which, though comparisons have been made from time to time for the last six months, no variation whatever can be observed.

We have thus a chain of instruments measuring from 1 centi-ampère to 500 ampères, which are, practically speaking, in absolute agreement among themselves, and whose constants have been determined separately, and in many cases by different observers, by the process of electrolysis of copper sulphate described in this paper. This fact not only proves the constancy and accuracy of the instruments, but also establishes beyond a doubt the great value of this method of standardising, and that it is equally applicable to currents of all magnitudes.

TABLES TO FACILITATE THE CALCULATION OF STRAINS OF OVERHEAD LINE WIRES.

TABLE I.

Strains on Suspended (Iron or Steel) Wires.

Col. I. Relation of sag to span. H : L	Col. II. Proportional strain. K	Col. III. Proportional length (span = 1) Z
1 to 10	4·67	1·02667
1 " 15	4·62	1·01185
1 " 20	8·61	1·00667
1 " 25	10·74	1·00427
1 " 30	12·83	1·00297
1 " 35	14·92	1·00218
1 " 40	17·02	1·00167
1 " 45	19·11	1·00132
1 " 50	21·21	1·00107
1 " 60	25·43	1·00074
1 " 70	29·64	1·00054
1 " 80	33·86	1·00042
1 " 90	38·07	1·00033
1 " 100	42·22	1·00027
1 " 110	46·52	1·00022
1 " 120	50·74	1·00019
1 " 130	54·96	1·00016
1 " 140	59·18	1·00014
1 " 150	63·40	1·00012
1 " 160	67·63	1·00010
1 " 170	71·85	1·00009
1 " 180	76·07	1·00008
1 " 190	80·30	1·00007
1 " 200	84·52	1·00006
1 " 225	95·08	1·00005
1 " 250	105·64	1·00004
1 " 275	116·21	1·00004
1 " 300	126·77	1·00003
1 " 350	147·89	1·00002
1 " 400	169·02	1·00002
1 " 450	190·14	1·00001
1 " 500	211·26	1·00001

RULES FOR USING THE ABOVE TABLE.

I. *The span and sag being given, to find the absolute strain per square inch section.*

Rule.—In Column I., find the nearest relation of sag to span, and opposite to it (in Column II.) the proportional strain (K). The absolute strain in lbs. is K times the span in feet.

Example.—If a steel wire were to be stretched across a river (span 2,340 feet), and on account of shipping only 39 feet sag could be allowed, what would be the absolute strain?

$$39 : 2340 :: 1 : 60.$$

In the table opposite the proportion 1 : 60 is given (Col. 2) the proportional strain (K) = 25·43 lbs. The absolute strain is, therefore, 25·43 × 2,340 = 59·506 lbs. per square inch.

II. *The span and sag being given, and also the sectional area of the wire in square inches, to find the actual strain in lbs.*

Rule:—In Col. 1 find the nearest relation of sag to span, and opposite to it (in col. 2) the proportional strain (K). Then the actual strain in lbs. is

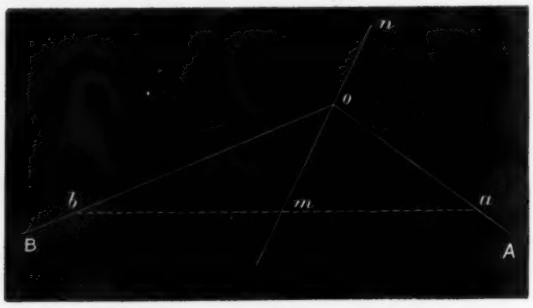
. K × area of wire × span in feet.

Example:—Span of 111 yards with a sag of 20 inches (= 1 to 200) required the actual strain of a No. 11 B.W.G. iron wire? In col. 1 opposite 1:200 we find $\kappa = 84{\cdot}52$. The sectional area of No. 11 wire is = 0·0125 sq. inch. Therefore the actual strain will be

$$84{\cdot}52 \times 0{\cdot}0125 \times 333' = 352 \text{ lbs.}$$

VI. *Two neighbouring spans having different strains and making an angle at the post being given, to find the proper direction for a strut or stay.*

Rule.—Find by the foregoing rules the two strains, measure off from the pole in the direction of each wire a length proportional to its strain, join the ends of the measured lengths by a straight line, the middle point of which sighted towards the post, gives the proper line of strut and stay.



Example:—From the post o are two wires. The strain of A is 600 lbs., that of B is 900 lbs.

I measure off in the direction o A, a length of 10 feet to *a*, and in the direction o B, a length of 15 feet to *b* (because 10 and 15 are proportional to 600 and 900). The points *a* and *b* I then join by a straight line, *a b*, the middle of which is at *m*. Therefore a strut should be placed in the line, *m* o. If I want a stay I sight the line on the other side of the post towards *n*, and place the stay in the direction *n* o.

VIII. *To find the actual* {stress / strain} *on a given* {strut / stay} *placed in the proper direction.*

Rule 1. Mark out by the method given in Rule VI. the line of direction, and measure the distance, *m* o, in feet. The horizontal strain on the post in the direction *n m* is equal to the actual strain on A in lbs. multiplied by twice *m* o in feet and divided by o *a* in feet.

2. Next measure downwards and mark from the point where the {strut / or stay} joins the post, a length of 10 feet on each, and with a tape measure the distance across in feet between the two marks.

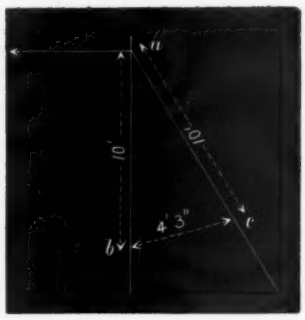
3. Find in Table II. (Col. I.) the nearest value to this distance, and with the corresponding figure in (Col. 2) multiply the horizontal strain found (in I.) above. The product is the actual strain on the {strut / or stay} in lbs.

TABLE II.

Strains on Struts or Stays.

Col. I.		Col. II.
Distance between strut or stay and post 10 feet down.		Proportional strain on strut or stay.
Feet.	Inches.	
2	0	5·02
2	3	4·47
2	6	4·03
2	9	3·67
3	0	3·37
3	3	3·12
3	6	2·90
3	9	2·71
4	0	2·55
4	3	2·41
4	6	2·28
4	9	2·17
5	0	2·07
5	6	1·89
6	0	1·75
6	6	1·63
7	0	1·53
7	6	1·44
8	0	1·36
8	6	1·30
9	0	1·24
9	6	1·20
10	0	1·16

Example.—The post in the example given with Rule VI. is provided with a stay in the line, *m* o. The length of the line, *m* o,



by measurement, I find to be 6′. The horizontal strain on the post is therefore

$$\frac{600 \times 2 \times 6}{10} = 720 \text{ lbs.}$$

I next mark off from the point (*a*), 10 feet (to *b* on the other post, and to *c* on the stay), and measure the distance across from *b* to *c*, which I find to be 4′ : 3″.

Lastly, I refer to Table II., and opposite 4′ : 3″ I find 2·41.

The strain on the stay is therefore

$$2{\cdot}41 \times 720 = 1{,}735 \text{ lbs.}$$

In this rule it is supposed that the strut or stay touches the post at the same height as the mean strain acts horizontally.

If, however, the strain acts higher or lower than the top of the strut or stay, the result found by the last rule must be multiplied by the height of the strain, and divided by the height of the top of the strut or stay, both being measured on the pole.

Example.—Suppose in the last example, the mean strain acts at 20 feet from the ground, but that the stay reaches only 15 feet up, then the actual strain will be

$$\frac{1{,}735 \times 20}{15} = 2{,}313 \text{ lbs.}$$

IX. *The resultant horizontal strain of the wires in the proper direction of a* {strut / or stay} *and the maximum strain which the* {strut / or stay} *is to bear being given, to find the angle at which it must be placed against the post.*

Rule (1). Find by Rule VIII. (1) the horizontal strain in lbs. acting in the proper direction of the {stay / or strut.}

(2). Divide the given maximum strain in lbs. by the horizontal strain in lbs., and find in col. 2, Table II., the nearest value to the quotient; col. I. then gives the distance which the {stay / strut} must stand from the post, at a point measured 10 feet down on each.

Example.—Suppose the horizontal strain, calculated by Rule VIII. (1) to be, as in the last example, = 720 lbs., and that a stay which must not bear more than 1,500 lbs. is to be used

$$\frac{1{,}500}{720} = 2{\cdot}08$$

In col. 2, Table II., the nearest value to this is 2·07, and in col. 1. the corresponding distance between the 10 feet marks is given, = 5 feet.

In dealing with overhead telegraph wires, the actual strain may be, without sensible error, taken as the horizontal strain, because they are generally allowed so little sag.

PUMPING IN MINES BY ELECTRICITY.

SOME four months ago the REVIEW and other technical papers contained descriptions of two pumping plants, in which the energy was transmitted from the surface to the pit bottom by electricity. The motor and dynamo for one of these were made by Messrs. Immisch & Co., of Kentish Town, London, and the work was carried out under their superintendence. The other was designed and erected by Mr. Brain, of the Trafalgar Colliery.

Both these installations are interesting as practical successes, but both are insignificant beside another pumping plant which Messrs. Immisch & Co. have now laid down at Messrs. Locke & Co.'s, St. John's Colliery, Normanton, designed to cope with a salt-feeder of 5,100 gallons per hour, at a vertical depth of nearly 900 feet below the surface.

It was decided to raise the water at one lift, and at a rate of about 7,200 gallons per hour; so that the pumps could stand, if necessary, for six hours out of the 24. Since the pressure on the ram faces is about 400 lbs. per square inch, specially designed pumps were required, and the electrical plant had to be devised to suit the conditions obtaining. The pumps are differential with two 6-inch and two 4½-inch rams, and when doing full duty they run at 25 revolutions per minute. It was found, by a preliminary trial of a smaller plant, that the load on the rams varied largely at different parts of the stroke. To avoid the heating that would be entailed in an ordinary motor working under a large current with a regular and rapid variation in its intensity, it was necessary to specially design the field and armature. Messrs. Immisch & Co. have successfully met the difficulty, and the plant has now been raising about 125,000 gallons per day for the last month. To give some idea of the electric problem, we may say that the current averages 66 ampères as read by a Siemens dynamometer, but varies at least 10 ampères on either side of the mean current. As Mr. Blakesley has told us, the heating effect of a varying current is not proportional to the square of the mean current, but is equal to that plus half the square of the variable part. This is not all, however; the rapid variations of current increase largely the heating effects due to hysteresis and Foucault currents.

The tension on the dynamo terminals is 600 volts, on the motor 575 volts. The actual H.P. in the water, at the rate of 120 gallons per minute through 900 feet, is 33 H.P. nearly. The output of the dynamo is 53 H.P. Hence the efficiency between the actual useful work and the output of the dynamo is $\frac{33}{53} = 62$ per cent. approx. The commercial efficiency or ratio of useful work to belt power in dynamo cannot yet be stated accurately, owing to slip in the dynamo belt. However, taking the efficiency of conversion of the dynamo at the low estimate of 85 per cent., the commercial efficiency is not less than $\frac{33}{62{\cdot}5} = 50$ per cent. approx.

It must be remembered that this efficiency includes all the losses in transmission—viz., that in the dynamo, leads, motor, gearing, pumps, and rising main pipes. In this particular case about 2·5 H.P. is lost in the cables and some 13 H.P. is absorbed by the gearing and pumps, and by friction of the water in the pipes. It is intended shortly to make a more complete test. Then indicator diagrams will be taken of the engines and pumps, and the various losses will be determined very exactly. But returning to our 50 per cent. conversion between the measured quantity of water and the brake engine power, could compressed air give such a return? The writer, from his experience in this class of work, believes that compressed air would not give a return of more than 20 per cent. of the brake engine power. At any rate, it is curious that not one of the advocates of pneumatic transmission will publish a test of his plant. The writer has spoken to several mining engineers who have carefully measured the water delivered, and indicated their engines with results varying from 15 per cent. to 25 per cent., and this latter under most favourable circumstances.

Several gentlemen have recently written in the columns of the technical Press advocating compressed air and doubting the practicability of electricity. Surely now is their time to vindicate their position by figures and hard facts. In comparing the two systems one must bear in mind that the losses in the steam engine, pumps, and rising main are common, and can therefore be neglected, as having no vital bearing on the real question. What we have to compare is the loss in dynamo cables and motor, and that in compressors, supply pipes, accumulators, and air engines. The loss in the cable and supply pipes may also be struck out as quantities varying in every case; they affect more the capital outlay. Now a good dynamo and motor have a joint conversion efficiency of not less than 75 per cent., and under favourable circumstances may rise as high as 82 per cent., or even 84 per cent. (see published tests). But what will the most sanguine say about the compressors and air engine? Will they claim 50 per cent. and give the figures, as electrical engineers do? Probably, under very favourable circumstances, with low pressures, 50 per cent. might be reached, but with high pressure (such as would be required for 7,000 gallons per hour through 900 feet, without an extravagantly large plant), the efficiency would be probably not more than 25 per cent.

Another important point of comparison lies in the prime cost of the plant. Omitting, again, the factors common to both systems, we have first a leading and return cable to set off against the pressure pipes. In most cases, the writer takes it, the cables will cost both less than the pipes and will be far cheaper to erect. A double cable to transmit 50 H.P. was run by Messrs. Immisch & Co. down a shaft 300 yards deep in 7 hours. The dynamo and motor will be found also to cost less than the compressors accumulators and air engine to do the same work. The former cost something like 25 per cent. less than the latter.

The question of prime costs is an important one, but, perhaps, that of maintenance and security of running is more important still, in cases where breakdowns may entail very serious consequences.

With electricity the cost of maintenance, judging from a large and varied experience of its application to nearly all kinds of machinery, is practically limited to the wear of brushes, commutators, and bearings.

The writer knows of several motors that have run for twelve months with one set of brushes, and of many that only require new brushes about every six months. A well made commutator also gives no trouble, and if kept clean will last for years. The bearings will last for a long time owing to the even strain put upon them. Of course, electrical plant requires to be properly designed for its work and to be well laid down. But the majority of accidents that are likely to happen to such plant can be readily and quickly repaired and compare very favourably with the ugly breakdowns that occur with machines containing reciprocating parts. Indeed, if a proper method of management and daily testing of the system be made, a really serious breakdown is a very unlikely thing, for a fault is easily detected and made good before damage is done. No one, who has had experience of the two systems, will fail to endorse this. With compressed air plant there is not so much a risk of a bad breakdown as a continual fettling up of the brasses, crank pins, cotters, valves, valve seats, glands, &c. The number of wearing parts is so numerous and the strains so various that it is not to be wondered that the cost of maintenance is comparatively heavy.

Concluding, it may be mentioned that the motor weighs about 3¼ tons, and the dynamo nearly 4 tons.

The machines are much heavier than the ordinary Immisch type for traction purposes, in which every 70 lbs. of dead weight gives approximately a brake horse-power. But here weight did not enter into the question so much as slow speed and cool running.

They are working well within the limits of their design, and are capable of doing 50 per cent. more work if necessary.

The armatures, 24 inches in diameter and 16 inches long, are of the cylinder type, with massive commutators and substantial brushes and holders. The motor is wound according to Immisch's patent, and to this is mainly attributed the fact that they run practically sparkless with a constant lead, although the load is varying 30 per cent. during every revolution of the pump. Electricians will appreciate what this means.

The speed of both dynamo and motor is 450 revolutions per minute.

The engine is a compound semi-fixed by Messrs. Robey & Co., of Lincoln, and works at a boiler pressure of 140 lbs. per square inch. It is a 30 H.P. nominal. Further particulars will be given when the full test is published.

That the plant is a success may be judged from the fact that Messrs. Locke & Co. have given an order for two new machines of the same power. This new plant will be used to work an endless rope on an engine plane by day, and will be ready for pumping at night if required.

This electrical plant is by far the largest at present running at a coal mine. It is confidently expected, however, that it will not long remain singular in this respect.

Telegraphic Communication.—In answer to Mr. Causton, in the House of Commons, on Tuesday, Mr. Raikes said: I have no official information of the inconvenience and loss which have resulted from the breakdown of telegraphic communication in New York, but I understand that the breakdown was caused by a snowstorm which damaged the wires. About 50 per cent. of the telegrams of the United Kingdom pass through the Central Telegraph Office in St. Martin's-le-Grand. Only on the top floor of that building are the fire hydrants not supplied from the street mains; they are supplied from tanks on the roof containing 28,000 gallons of water pumped up from the artesian well on the premises. It is not true that the building was in any danger from a fire in Paternoster Row. The present arrangements have been made after mature consideration, and there is no intention to establish a duplicate Central Telegraph Office. The building, I may add, is fireproof throughout.

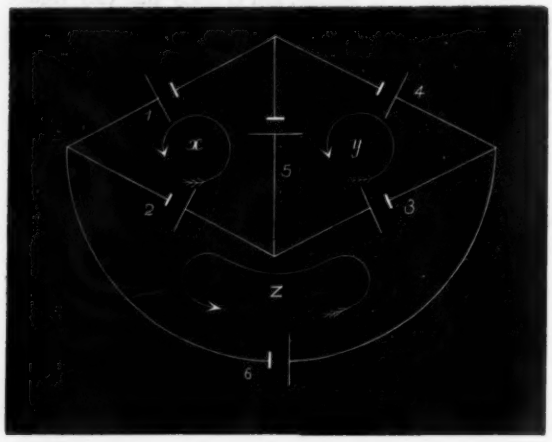
Organ Blowing by Electricity.—The organ at St. John's Church, Taunton, is to be blown by electricity. The posts to carry the wires have been fixed, and the work will be finished in about a week. It is being done by the Taunton Electric Light Company, and is creating great interest.

KIRCHOFF'S LAWS AND THEIR APPLICATION.

By E. C. RIMINGTON.

(*Continued from page* 310.)

CONSIDER any network, for simplicity one formed of six conductors has been taken, and suppose E.M.Fs. to act in any or all of the branches.



The equations obtained are :

$$(r_1 + r_2 + r_5)\,x - r_5\,y - r_2\,z = e_1 + e_2 - e_5$$
$$-r_5\,x + (r_3 + r_4 + r_5)\,y - r_3\,z = -e_3 - e_4 + e_5$$
$$-r_2\,x - r_3\,y + (r_2 + r_3 + r_6)\,z = -e_2 + e_3 + e_6$$

Hence

$$x = \frac{\begin{vmatrix} \overline{e_1 + e_2 - e_5} & -r_5 & -r_2 \\ \overline{-e_3 - e_4 + e_5} & \overline{r_3 + r_4 + r_5} & -r_3 \\ \overline{-e_2 + e_3 + e_6} & -r_3 & \overline{r_2 + r_3 + r_6} \end{vmatrix}}{\Delta}$$

$$= \frac{(e_1 + e_2 - e_5)\begin{vmatrix} \overline{r_3 + r_4 + r_5} & -r_3 \\ -r_3 & \overline{r_2 + r_3 + r_6} \end{vmatrix}}{\Delta}$$

$$+ \frac{(-e_3 - e_4 + e_5)\begin{vmatrix} -r_3 & \overline{r_2 + r_3 + r_6} \\ -r_5 & -r_2 \end{vmatrix}}{\Delta}$$

$$+ \frac{(-e_2 + e_3 + e_6)\begin{vmatrix} -r_5 & -r_2 \\ \overline{r_3 + r_4 + r_5} & -r_3 \end{vmatrix}}{\Delta}$$

$$= \frac{e_1\begin{vmatrix} \overline{r_3 + r_4 + r_5} & -r_3 \\ -r_3 & \overline{r_2 + r_3 + r_6} \end{vmatrix}}{\Delta}$$

$$+ \frac{e_2\left\{\begin{vmatrix} \overline{r_3+r_4+r_5} & -r_3 \\ -r_3 & \overline{r_2+r_3+r_6} \end{vmatrix} - \begin{vmatrix} -r_5 & -r_2 \\ \overline{r_3+r_4+r_5} & -r_3 \end{vmatrix}\right\}}{\Delta}$$

$$+ \frac{e_3\left\{\begin{vmatrix} -r_5 & -r_2 \\ \overline{r_3+r_4+r_5} & -r_3 \end{vmatrix} - \begin{vmatrix} -r_3 & \overline{r_2+r_3+r_6} \\ -r_5 & -r_2 \end{vmatrix}\right\}}{\Delta}$$

$$- e_4\frac{\begin{vmatrix} -r_3 & \overline{r_2 + r_3 + r_6} \\ -r_5 & -r_2 \end{vmatrix}}{\Delta}$$

$$+ \frac{e_5\left\{\begin{vmatrix} -r_3 & \overline{r_2+r_3+r_6} \\ -r_5 & -r_2 \end{vmatrix} - \begin{vmatrix} \overline{r_3+r_4+r_5} & -r_3 \\ -r_3 & \overline{r_2+r_3+r_6} \end{vmatrix}\right\}}{\Delta}$$

$$+ e_6\frac{\begin{vmatrix} -r_5 & -r_2 \\ \overline{r_3 + r_4 + r_5} & -r_3 \end{vmatrix}}{\Delta}$$

Now, the first term is obviously the value of x, which represents the currrent in branch 1, if all the E.M.Fs. are made zero except e_1, or is the current through r_1 due to e_1 acting alone, similarly the second term is the current through r_1 due to e_2 acting alone and so on for the other terms. Hence the current through r_1 when all the E.M.Fs. act is the sum of the currents that would flow through it when each E.M.F acts separately. It is also obvious that the above is true for any network however complicated. We have then the following rule :—"The current in any branch of a network due to E.M.Fs. acting in various branches is the algebraical sum of the currents in that branch due to each E.M.F. considered separately, all the others being supposed zero."

Again, it will be seen that if any one of the E.M.Fs. acting alone send no current through one of the branches, the current in that branch due to all the E.M.Fs. acting at the same time, will be unaltered whatever value be given to the E.M.F., which when acting by itself produces no current through the branch in question, since the coefficient of this E.M.F. must be zero in the term which represents the current due to it. The branch containing the E.M.F. is said to be *conjugate* to the branch through which it sends no current. The current in r_1 due to e_3 acting in branch 3

$$= \frac{e_3\left\{\begin{vmatrix} -r_5 & -r_2 \\ \overline{r_3 + r_4 + r_5} & -r_3 \end{vmatrix} - \begin{vmatrix} -r_3 & \overline{r_2 + r_3 + r_6} \\ -r_5 & -r_2 \end{vmatrix}\right\}}{\Delta}$$

If this current be zero.

$$\begin{vmatrix} -r_5 & -r_2 \\ \overline{r_3 + r_4 + r_5} & -r_3 \end{vmatrix} - \begin{vmatrix} -r_3 & \overline{r_2 + r_3 + r_6} \\ -r_5 & -r_2 \end{vmatrix} = 0$$

Therefore in the expression for x, the current due to all the E.M.Fs., the third term vanishes, whatever be the value of e_3. Branch 3 is therefore conjugate to branch 1, when

$$\begin{vmatrix} -r_5 & -r_2 \\ \overline{r_3 + r_4 + r_5} & -r_3 \end{vmatrix} = \begin{vmatrix} -r_3 & \overline{r_2 + r_3 + r_6} \\ -r_5 & -r_2 \end{vmatrix}$$

That is when

$$r_3\,r_5 + r_2\,r_3 + r_2\,r_4 + r_2\,r_5 = r_2\,r_3 + r_2\,r_5 + r_3\,r_5 + r_5\,r_6$$

or when $$r_2\,r_4 = r_5\,r_6$$

It will be seen that no other branch in the above network is conjugate to branch 1, since, in the expression for x, none of the coefficients of the E.M.Fs. are zero with the exception of that of e_3 : also since this latter coefficient reduces to $r_2\,r_4 - r_5\,r_6$, which does not contain r_3, the current in branch 1 is independent of the resistance of r_3 as well as of the value of e_3.

Similarly it may be shown that branches 2 and 4 are conjugate, when $r_1\,r_3 = r_5\,r_6$, and branches 5 and 6 when $r_1\,r_3 = r_2\,r_4$.

The value of the current in branch 4, or

$$y = \frac{\begin{vmatrix} \overline{r_1 + r_2 + r_5} & \overline{e_1 + e_2 - e_5} & -r_2 \\ -r_5 & \overline{-e_3 - e_4 + e_5} & -r_3 \\ -r_2 & \overline{-e_2 + e_3 + e_6} & \overline{r_2 + r_3 + r_6} \end{vmatrix}}{\Delta}$$

When all the E.M.Fs. are zero except e_1 :

$$y = \frac{e_1 \begin{vmatrix} -r_3 & -r_5 \\ \overline{r_2+r_3+r_6} & -r_2 \end{vmatrix}}{\Delta}$$

When all the E.M.Fs. are zero except e_4 :

$$x = \frac{e_4 \begin{vmatrix} -r_3 \overline{r_2+r_3+r_6} \\ -r_5 \quad -r_2 \end{vmatrix}}{\Delta} = \frac{e_4 \begin{vmatrix} -r_3 & -r_5 \\ \overline{r_2+r_3+r_6} & -r_2 \end{vmatrix}}{\Delta}$$

Hence if $e_1 = e_4$, $x = y$; or the current produced in branch 4 by any E.M.F. acting in branch 1 is the same as the current produced in branch 1 by the same E.M.F. acting in branch 4. Similarly it may be shown for any two branches in the diagram that the current produced in any one branch by any E.M.F. acting in any other branch is the same as the current produced in the latter by the same E.M.F. acting in the former : if this current is zero the branches are conjugate, and, consequently, *if one branch is conjugate to another, the latter is also conjugate to the former :* in other words, if any E.M.F. acting in one branch send no current through some other, any E.M.F. acting in the latter will send no current through the former.

In the expression for x the coefficient of e_2 in the numerator of the second term viz. :

$$\begin{vmatrix} \overline{r_3+r_4+r_5} & -r_3 \\ -r_3 & \overline{r_2+r_3+r_6} \end{vmatrix} - \begin{vmatrix} -r_5 & -r_2 \\ \overline{r_3+r_4+r_5} & -r_3 \end{vmatrix}$$

may be written

$$\begin{vmatrix} \overline{r_3+r_4+r_5} & -r_3 \\ -r_3 & \overline{r_2+r_3+r_6} \end{vmatrix} + \begin{vmatrix} \overline{r_3+r_4+r_5} & -r_3 \\ -r_5 & -r_2 \end{vmatrix},$$

which may by rule (4), page 255, be written as the one determinant

$$\begin{vmatrix} \overline{r_3+r_4+r_5} & -r_2 \\ \overline{-r_3-r_5} & \overline{r_3+r_6} \end{vmatrix}$$

In the same manner the coefficients of the other E.M.Fs. may be obtained as single determinants, and we have

$$x = \frac{e_1 \begin{vmatrix} \overline{r_3+r_4+r_5} & -r_3 \\ -r_3 & \overline{r_2+r_3+r_6} \end{vmatrix}}{\Delta} + \frac{e_2 \begin{vmatrix} \overline{r_3+r_4+r_5} & -r_3 \\ \overline{-r_3-r_5} & \overline{r_2+r_6} \end{vmatrix}}{\Delta}$$

$$+ \frac{e_3 \begin{vmatrix} -r_5 & -r_2 \\ \overline{r_4+r_5} & \overline{r_2+r_6} \end{vmatrix}}{\Delta} + \frac{-e_4 \begin{vmatrix} -r_3 \overline{r_2+r_3+r_6} \\ -r_5 \quad -r_2 \end{vmatrix}}{\Delta}$$

$$+ \frac{e_5 \begin{vmatrix} -r_3 \overline{r_2+r_3+r_6} \\ \overline{r_3+r_4} \quad \overline{-r_2-r_3} \end{vmatrix}}{\Delta} + \frac{e_6 \begin{vmatrix} -r_5 & -r_2 \\ \overline{r_3+r_4+r_5} & -r_3 \end{vmatrix}}{\Delta}$$

It will be noticed that none of the numerators contain r_1, the resistance of the branch, in which the current is x, also that the coefficient of any E.M.F. does not contain the resistance of the branch in which that E.M.F. acts. It can moreover be seen that the above is true for any network from the consideration of the method of forming the equations to the network.

Consider now the above principles in their general form as applied to any network. Let R be the resistance of any branch, C the current, and E the E.M.F. in it, and V and V_1 the potentials at its extremities. From the general form of Ohm's law, $C = \frac{V - V_1 + E}{R}$, or $V_1 - V = E - CR$. If $C = 0$, $V_1 - V = E$ and is independent of the value of R.

Now since the potentials at the ends of this branch are unaltered when its resistance is varied, the currents in the other branches and the potentials of the other points of the network must also remain constant. We have then the following law :

"If, in any network, the current through any conductor be zero, the resistance of this conductor may be varied from zero to infinity without affecting the current in, or the potential difference of, any of the other branches." The above is generally known as Bosscha's first corollary to Kirchoff's laws.

Suppose now in a branch, in which the current and E.M.F. are C and E, and whose resistance is R, we alter R to R_1 and, at the same time, alter E to E_1, so that C, V, and V_1 shall remain unchanged, we have :

$$V_1 - V = E - CR = E_1 - CR_1$$

Hence $E_1 - E = C(R_1 - R)$; or the alteration necessary to be made in the E.M.F. equals the current flowing in the branch into the alteration in its resistance.

If $E = 0$, $E_1 = C(R_1 - R)$; that is if no E.M.F. already exists in the branch, one must be inserted in it equal to the product of the current into the increase in resistance. Since the current in the branch and the potentials at its extremities are kept constant, it is obvious that the currents in the other branches and the potentials of the other points of the network are unaffected.

In any network of conductors containing no E.M.F. let any E.M.F., e, be inserted in any branch, a, and let C_{ba} be the current produced in some other branch, b, in consequence of the E.M.F., e, in a. We may write

$$C_{ba} = \frac{e\,\delta_{ba}}{\Delta} ;$$

where δ_{ba} is some determinant whose constituents are formed of the resistances of the different branches, but which, as was shown further back, does not contain the resistances of the conductors a and b. Δ is a determinant containing the resistances of all the branches.

Similarly the current in branch a due to an E.M.F., e, acting in b, or

$$C_{ab} = \frac{e\,\delta_{ab}}{\Delta} ;$$

where δ_{ab} is independent of a and b.

Therefore $$\frac{C_{ab}}{C_{ba}} = \frac{\delta_{ab}}{\delta_{ba}}$$

and is independent of a and b.

Let x be any branch of the network.

$$C_{xa} = \frac{e\,\delta_{xa}}{\Delta} \qquad C_{xb} = \frac{e\,\delta_{xb}}{\Delta}$$

where δ_{xa} and δ_{xb} are both independent of the resistance of x.

$$\frac{C_{xa}}{C_{xb}} = \frac{\delta_{xa}}{\delta_{xb}}$$

and is independent of x.

Suppose now an E.M.F., e, is inserted in b, the resistance of x to be altered to x', and an E.M.F. $= C_{xb}(x' - x)$ at the same time put into x ; C_{xb} being the current through x due to E.M.F., e, in b ; this will not affect the value of C_{ab}. Let the value of δ_{ab} become δ'_{ab} in consequence of the alteration in the value of x ; similarly let δ_{ba} become δ'_{ba} and Δ, Δ'.

Then $$C_{ab} = \frac{e\,\delta'_{ab}}{\Delta'} + \frac{(x' - x)\,C_{xb}\,\delta'_{ax}}{\Delta'} ;$$

because the current in a is equal to the sum of the currents produced by each E.M.F. acting separately : δ'_{ax} involves neither a nor x.

Now $$C_{xb} = \frac{e\,\delta_{xb}}{\Delta}$$

Hence $$C_{ab} = \frac{e\,\delta'_{ab}}{\Delta'} + \frac{(x' - x)\,\delta'_{ax}}{\Delta'} \cdot \frac{e\,\delta_{xb}}{\Delta}$$

but C_{ab} has the same value as before.

Therefore

$$e\left(\frac{\delta_{ab}}{\Delta}-\frac{\delta'_{ab}}{\Delta'}\right)=\frac{e\,(x'-x)\,\delta'_{ax}\,\delta_{xb}}{\Delta\,\Delta'}$$

Similarly

$$e\left(\frac{\delta_{ba}}{\Delta}-\frac{\delta'_{ba}}{\Delta'}\right)=\frac{e\,(x'-x)\,\delta'_{bx}\,\delta_{xa}}{\Delta\,\Delta'}$$

Dividing one equation by the other

$$\frac{\frac{\delta_{ab}}{\Delta}-\frac{\delta'_{ab}}{\Delta'}}{\frac{\delta_{ba}}{\Delta}-\frac{\delta'_{ba}}{\Delta'}}=\frac{\delta'_{ax}}{\delta'_{bx}}\cdot\frac{\delta_{xb}}{\delta_{xa}}.$$

Now, $\frac{\delta'_{ax}}{\delta'_{bx}}$ and $\frac{\delta_{xb}}{\delta_{xa}}$ are both independent of x; hence the left-hand side of the equation must be independent of x.

Now, it is known that $\frac{\delta_{ab}}{\Delta}$ is not independent of x and that $\frac{\delta'_{ab}}{\Delta'}$ is the same function of x' that $\frac{\delta_{ab}}{\Delta}$ is of x; also $\frac{\delta'_{ba}}{\Delta'}$ is the same function of x' that $\frac{\delta_{ba}}{\Delta}$ is of x, of which neither are independent. In order, therefore, to make the left-hand side of the equation independent of x, it is necessary that $\frac{\delta_{ab}}{\delta_{ba}}=\frac{\delta'_{ab}}{\delta'_{ba}}=p$, where p is some quantity independent of x; but x represents the resistance of *any* branch; therefore p must be independent of the resistance of any branch of the network and must consequently be some number.

Again, since $\frac{\delta'_{ax}}{\delta'_{bx}}$ is independent of x, it equals $\frac{\delta_{ax}}{\delta_{bx}}$

Hence

$$\frac{\delta'_{ax}}{\delta'_{bx}}\cdot\frac{\delta_{xb}}{\delta_{xa}}=\frac{\delta_{ax}}{\delta_{bx}}\cdot\frac{\delta_{xb}}{\delta_{xa}}$$

$$=\frac{\delta_{ax}}{\delta_{xa}}\cdot\frac{\delta_{xb}}{\delta_{bx}}$$

But since $\frac{\delta_{ax}}{\delta_{xa}}$ is independent of x, the latter may have any value in the expression; let it equal b, then

$$\frac{\delta_{ax}}{\delta_{xa}}=\frac{\delta_{ab}}{\delta_{ba}}=p$$

Similarly if $x=a$,

$$\frac{\delta_{xb}}{\delta_{bx}}=\frac{\delta_{ab}}{\delta_{ba}}=p$$

Hence

$$\frac{\frac{p\,\delta_{ba}}{\Delta}-\frac{p\,\delta'_{ba}}{\Delta'}}{\frac{\delta_{ba}}{\Delta}-\frac{\delta'_{ba}}{\Delta'}}=p\,.\,p$$

or $$p=p^2$$

Hence $p=1$, that is $\delta_{ab}=\delta_{ba}$

or $c_{ab}=c_{ba}$, that is to say;

*the current produced in any branch, a, of a network by any E.M.F., e, acting in some other branch, b, is equal to the current produced in b by the same E.M.F. acting in a.**

If c_{ab} be zero, c_{ba} is also zero, that is if b be conjugate to a, a is also conjugate to b.

This gives the following law.

"If, in any network of conductors, there be two A and B such that any E.M.F. inserted in A sends no current through B, then any E.M.F. inserted in B will produce no current through A, and A and B are said to be conjugate to one another. If now E.M.Fs. are inserted in any or all of the branches of the network so as to produce a current in A, the E.M.F. in, and the resistance of B may be altered to any extent without affecting the value of this current. In the same manner the E.M.F. in and the resistance of A may be altered without affecting the current through B."

The above may be put in fewer words thus:

"In any network when two conductors are conjugate, the E.M.F. in and the resistance of either of them may be altered to any extent without affecting the condition of the other."

The portion of this law that relates to the alteration in the resistance of one of the conjugate conductors not affecting the other is generally known as Bosscha's second corollary to Kirchoff's laws.

The current in any branch, y, of any network, due to E.M.Fs. acting in any or all of the branches, may be written

$$c_y=\frac{e_a\,\delta_{ya}}{\Delta}+\frac{e_b\,\delta_{yb}}{\Delta}+\ldots+\frac{e_x\,\delta_{yx}}{\Delta}+\ldots+\frac{e_y\,\delta_{yy}}{\Delta}$$

Where δ_{yx} is independent of both x and y.

Suppose now x is altered to x', this is equivalent, as was shown before, to keeping x constant and inserting in it an E.M.F., e, equal to the current through x multiplied by $(x'-x)$, and the value of the current in y will therefore be

$$c_{y'}=\frac{e_a\,\delta_{ya}}{\Delta}+\frac{e_b\,\delta_{yb}}{\Delta}+\ldots+\frac{(e_x+e)\,\delta_{yx}}{\Delta}+\ldots+\frac{e_y\,\delta_{yy}}{\Delta}$$

If $\delta_{yx}=0$ the term $\frac{(e_x+e)\,\delta_{yx}}{\Delta}$ becomes also zero and independent of the values of e_x and of e.

Hence $c_y'=c_y$ whatever values are given to e_x and x. If now all the E.M.Fs. are made zero with the exception of e_x, c_y will be zero and consequently x and y conjugate: in words—

"When in any network any alteration in the E.M.F. in, or the resistance of, one of the branches produces no alteration in the current in some other, those two branches are conjugate."

This is the converse of the corollary previously given.

(*To be continued.*)

* For the substance of the above proof of this important principle the writer is indebted to a paper read by W. E. Sumpner before the City and Guilds Old Students' Association.

NOTES.

Weston-super-Mare and the Electric Light.—Beautiful Weston has not yet relinquished the idea of electrically lighting its streets. Other reforms are also agitating the breasts of its inhabitants, and the introduction of a refuse destructor is advocated; following upon this is the suggestion that the heat arising from the consumption of refuse should not be wasted, but utilised as the motive force for electric lighting.

Lighting in Berlin.—The larger hotels in Berlin are beginning to introduce electric lighting to a greater extent than has hitherto been the case. The new hotel "Thiergarten," which was erected last year, has now been fitted throughout with glow lamps, the current being supplied from the central station in the Mauerstrasse. This is the first hotel in this town, says *Industries*, which relies solely upon electricity, no gas or other illuminant being used as reserve. In the new restaurant Gambrinus, gas has also been completely discarded in favour of electricity. The electric light installation in the Continental Hotel, which comprises 1,000 glow lamps, has recently been completed. The work was carried out by the Allgemeine Elektricitäts Gesellschaft on their own account, the customers only paying for the current used, but not for the cost of putting up the installation.

Taunton and the Electric Light.—Tauntonians generally are pleased with the electric light, whatever its detractors may say to the contrary, and the Town Council has resolved to have 30 additional lamps erected in different parts of the town.

Electric Light at a Photographer's.—The premises of Messrs. Mayall & Co., Limited, in New Bond Street, are at present undergoing extensive alterations and extensions. One of the special features will be an extended system of electric lighting, which is being installed by Messrs. Henry F. Joel & Co., of Finsbury. The installation consists of three 6,000 to 10.000-candle-power arc lamps, for photographic purposes. The reception rooms, studios, entrances, &c., are fitted with 50 20-candle-power incandescent lamps. The power used is an 8 horse power gas engine. This drives a Joel dynamo, a countershaft, and fast and loose pulleys. The incandescent lamps are run off the Grosvenor Gallery central station. A main switch is so arranged that the current from the Grosvenor Gallery can be shut "off," and the dynamo put "on" to the incandescent lamps at will, or, *vice versâ*; the arc lamps may, too, run from the Grosvenor Gallery circuit.

The Electric Lighting Act.—A bill to amend the Electric Lighting Act, 1882, has been introduced into the House of Lords by the Earl of Crawford. The bill is explained by a memorandum to the following effect:—"The provisions of the Electric Lighting Act, 1882, have been found by experience to be of a nature so stringent as to shut out the public from the advantages they were presumed to obtain from commercial application of scientific knowledge. The bill is divided into heads treating of—(1) Method of procedure between Local Authority and undertakers; (2) Systems of supply of current; (3) Powers conferred on undertakers for works; (4) Such works as shall be compulsory; (5) Maps and plans required; (6) Procedure in testing; (7) Supply of current to consumers; (8) Price of current supplied; (9) On meters and apparatus; (10) Notices and service thereof; (11) Procedure for determining liabilities of undertakers, and for regulating terms of purchase; (12) General. The principal changes of the existing law proposed by this bill are—(*a*) Freedom of contract as between local authorities and undertakers (additional to present forms of procedure); (*b*) Payment to Local Authority of rent for wayleaves; (*c*) Mains and cables to be underground after a certain lapse of time; (*d*) Terms of purchase by the Local Authority. The greater part of the details of the bill have been adapted to the present circumstances from the Gasworks Clauses Act, 1871, and which are in fact presently the law as regards the parish of Chelsea, under an Act passed on the 25th September, 1886 (50 Vic., local, ch. 18). So far as consistent with a public Act, the provisions of the Chelsea Act have been brought into this bill."

Ship Lighting.—The armoured twin-screw double-turret ram *Nile*, launched at Pembroke Dockyard on Tuesday, is to be lighted by about 500 incandescent lamps, to work which and four large search lights three dynamos, each of 400 ampère-power, will be provided.

Theatre Lighting.—We have been informed that the new Metropolitan Theatres Bill will contain a clause making it compulsory on the part of theatre proprietors and lessees to adopt electric lighting. This, if true, is indeed good news.

Electric Lighting of the Brussels Exhibition.—On the 25th inst. the Executive Committee will make final arrangements for giving out the work for the electric lighting of the buildings and gardens of the Exhibition. Offers, according to *Industries*, have been made by many electricians to supply various apparatus free of charge, both for arc and incandescent lighting; but other offers were on the basis of payment per lamp-hour, the average price asked being from 2d. to 3d. for a 10 to 12 ampère arc, and of ·3d. to ·35d. per 16 candle-power glow lamp. For the arc lighting offers have been received from the following: The Thomson-Houston Company (engineer, M. Admirallie), 75 2,000 nominal candle-power lamps, with an 80 H.P. steam engine; Messrs. Bouckaert & Co., of Brussels, 4 lamps of 25 ampères, 6 of 16 ampères, 42 of 10 ampères, and 16 of 6 amperes; M. Dulait, of Charleroi, 25 lamps of 15 amperes, 4 of 24 ampères, and 6 of 4 ampères, all at 35 volts; Messrs. Jaspar, of Liège, 20 lamps of 12 and 6 ampères; the Gülcher Electric Light Company, lamps of 10 ampères, &c. For incandescent lighting the following have made offers: M. Dulait, 200 lamps; M. Khotinsky, 500 lamps; M. Bury, 500 lamps; l'Industrielle, 750 lamps; and Mr. Bernstein, 150 lamps of 30 C.P. to 50 C.P. In the machinery section there will be three rows of 10 ampère arc lamps, 17 in each row, and one row of 16 ampère lamps will be placed in two rows on either side. The 10 ampère lamps are hung at a height of 30 feet, and the 16 ampère lamps at a height of 42 feet, the object of the latter being to illuminate the side galleries, which are 20 feet above the floor. There is a 10 ampère arc lamp provided for every 1,900 square feet of floor space. M. Pieper, of Liège, has already obtained a concession for lighting the aquarium, the casino, and the German breweries. He will also work the electric tramway.

Electric Lighting of a Steam Yacht.—The steam yacht *Wanderer*, a magnificent vessel, owned by Prince Torlonia, of Rome, has just been fitted with a very elaborate installation of electric light by Messrs. Muir, Mavor and Coulson, of Glasgow. The plant consists of the following:—A steam boiler built on a modification of Coles's patent, designed to give 12 indicated horse-power at 80 lbs. pressure; a Willans's compound central valve two-crank engine, mounted on the same bed-plate with and coupled direct to the dynamo, which is driven at 445 revolutions per minute (the engine is fitted with sight feed lubricator, tachometer, and Willans's governor); a dynamo with a maximum output of 10,000 watts, giving an E.M.F. of 75 volts as a simple shunt for charging batteries, and 60 volts as compound for running the lamps direct; a complete auxiliary condensing plant, consisting of a copper condenser and a set of circulating air and feed-pumps, mounted on the same bed-plate with and driven through worm gearing by a special double-acting high-speed vertical engine; an accumulator with a capacity of 630 ampère-hours, the plates of which are in teak wood boxes, which are carried on massive racks and rigidly secured by wedges. The space available for fixing the above plant is admirably suited to the purpose, being two large cabins on the main deck abreast of the engine room, with doors opening to the middle platform. Steam connections are provided from both the main boilers besides from the auxiliary boiler. The engine has also three alternative exhausts: first, to the main condenser for use while at sea and steaming from the main boilers; second, to the auxiliary condenser above mentioned for use while in port; and third, through a non-return valve to the atmosphere under the water-line. The hot feed water from the auxiliary hot well may be delivered to either or both the main boilers, or to the auxiliary boiler. The drains may be directed to the bilge or to the auxiliary condenser. The main conductors from the dynamo are brought to a handsomely fitted switch-box with instruments mounted, affording very complete control of the circuits and accumulator. A search-light of 2,000 candle-power is fitted on the navigating bridge, and a gangway lamp of 200 C.P., in a large lantern, is suspended over the ship's side from a special davit. The fittings throughout are of very handsome patterns, and the wiring has been carried out with special reference to neatness and security. The mains are brought to double pole fuse boxes with slate bases, where the fuses are centralised, and the branch wires led away in grooved casings of maple or Hungarian ash, with polished covers. The contractors have spared no trouble in their efforts to make this one of the most complete sets of apparatus afloat.

The Telephone and Criminal Offences.—An extract from the report of the Chief Constable of Dumbarton says :—"The telephone connections, which have now been in use for about a year between headquarters and the principal police stations of the county, including Glasgow, have been found to be most useful and economical for the police service. This has been specially shown in six serious offences (one culpable homicide), where the offenders absconded (principally during the night), and by means of the telephone the police were successful in apprehending accused a few minutes after the offences were reported, some of whom were got 20 miles from where the offences were committed."

The Telephone in Devonshire.—At the last monthly meeting of the Totnes Town Council the Western Counties Telephone Company applied for permission to erect poles in the borough to connect Totnes with Paignton, Torquay, and Newton. Leave was granted.

Telephone Patents.—The Equitable Telephone Association, against whom, our readers will remember, the United Telephone Company has obtained an injunction, has issued a statement in which it seeks to justify "the conduct of its past business." It claims to have given the United Telephone Company fair notice at an early period of its intentions, but to have been taken by surprise, after the lapse of more than a twelvemonth, by the issue of a writ by the United Company on the 9th inst. A motion for an injunction followed on the 16th, the Equitable Association having no time in the interim to prepare a scientific defence. Undue delay was therefore set up, but this the judge overruled. The Association asserts that it has every intention of contesting the action to the utmost of its ability, and to press the case on as far as lies in its power.

Pacific Ocean Cable Connections.—The Imperial Colonial and United States Governments have under consideration the three following proposed routes for westward cable connections with Japan, China, and the Australian Colonies :—F. N. Gisborne's project :—Vancouver Island to Alaska Peninsula, 1,350 nautical miles ; Alaska to Atton, Alentian Islands, 800 miles ; Atton to Yezzo, Japan, 1,300 miles, plus 10 per cent. for slack cable = 3,795 miles, the longest electrical link being 1,485 miles, and the total estimated cost at $700 per knot = $2,656,500. Cyrus W. Field's project :—San Francisco to Sandwich Islands, 2,093 miles ; Sandwich Islands to Japan, 3,600 miles, plus 10 per cent. slack = 6,262 miles, longest link 3,960 miles, estimated cost $4,383,400. Sandford Fleming's project :—Vancouver Island to Sandwich Islands, 2,450 miles ; Sandwich Islands to Fanning Islands, 1,060 miles ; Fanning to Fiji Islands, 2,070 miles ; Fiji to North Cape, Australia, 1,040 miles ; North Cape to Sydney, 900 miles, plus 10 per cent. slack = 8,272 miles, longest link 2,695 miles, estimated cost $5,795,400.

The Elieson Locomotive in America.—Some excerpts follow from the *Buffalo Express* report of the trial trip of the Elieson electric locomotive taken over to America from England by Messrs. Morton & Robison. We give the actual language of the American paper, as it affords an illustration both of the transatlantic journalistic method and the enthusiasm with which electric locomotion is taken up in the States :—"If anything were needed to convince the Buffalo Street Railroad Company that the city is ripe for rapid transit, conclusive proof was furnished yesterday in the general outpouring of the population to witness the exhibition trip of the new electric motor. A regular circus-day crowd lined the main street sidewalks from Seneca Street to The Genesee, and never was the triumphal chariot at the head of a glittering cavalcade hailed with greater demonstrations of delight than were seen on all sides when the imported precursor of better street car facilities finally made its appearance. 'We are looking forward with longing to the time when we can sell our horses, put in a big engine and a lot of dynamos, and become an electric railway from end to end,' said President Watson. 'But such radical changes ought not, as a matter of business policy, to be made until it is conclusively proven that electricity can be economically used as a substitute for horse-power. Our tracks and stables are at the service of any manufacturer of electric motors for street cars who has sufficient confidence in his motor to bring it here at his own expense to demonstrate its utility. He will not be one whit more anxious to convince us that it solves the problem than we will be to have him. I believe the Elieson motor is one of the best made, so far, and we have borrowed the one you will see work to-day, and brought it across the ocean at our own expense to see if it can be adapted to the conditions of the service here. Do not expect too much of it. In the first place, the wheels are lighter and the flanges much narrower than our standard car wheels, and for this reason it is apt to jump the tracks unless great care is exercised. This will materially reduce the possible speed. Then, again, Mr. Robison, the expert electrician, who will operate it, is wholly unacquainted with the route over which it will travel, and has had no experience in running it over our tracks. So, from beginning to end it will be a cautious trip, with no attempts to make the possible 12 miles an hour.' The Press party, President Watson, and some of the street railway *employés* took their places in the car, the starting-bell was rung, the lever thrown over, and the exhibition trip was begun. A crowd of from 200 to 300 had gathered at the barns, and the teams standing in the street and hitched to the fences suggested a country fair. As the motor and car began to move southward a shout went up from the assembly, and the teams quickly formed themselves into an improvised procession three abreast in the rear. The small boys ran along on the sidewalk on either side shouting and gesticulating, fresh recruits taking the places of those who fell out, thus keeping up the excitement. At every street corner a large assemblage was gathered, and as the first exponent of coming rapid-transit swept by the men cheered and the ladies waved their handkerchiefs. It was more like the march of an army with banners than a simple test of a new propelling device. Electrician Robison stood in the front door of the Motor Cab with his right hand upon the speed regulator, while with the other he grasped the cord of the warning bell. While rounding curves and crossing switches, as well as at the intersections of the principal streets, the speed was brought down to a snail's pace as a precautionary measure ; but while traversing the long blocks where the track is in excellent condition, the Motor was permitted to bowl along at the rate of eight or nine miles per hour for short distances, to show what it was capable of doing in actual service. Up and down the grades it moved at about the same rate of speed, the power being shut off wherever gravity would give the requisite propulsion. The motion of the car was pleasanter and less jerky than where horse power is used, particularly in starting and stopping, while the noise was reduced sufficiently to permit of easy conversation without raising the voice. Finally, just at five o'clock, the excursionists reached the waiting-room at the corner of Niagara and Main Streets once more, and the party dispersed, pleased and happy in the thought that the feasibility of rapid transit, so far as the public is concerned, has been demonstrated at last in the streets of Buffalo.

Overhead Wires.—The Sydenham and Forest Hill Local Committee of the Lewisham Board of Works reported to the Board last week, that the United Telephone Company had erected six wires across the Board's yard at Forest Hill, without the sanction of or notice to the Board as freeholders and owners of the property. The committee recommended that a letter be written to the company requiring them to remove the wires referred to, and instructions were given accordingly. The surveyor also reported to the Board that the Telephone Company had broken up a portion of the footway leading from Park End to Forest Hill Station and had put up wires without giving notice to the Board. The report was referred to the local committee with power to act.

Red Sea Cables.—We learn from a contemporary that the cables laid between Massowah, Assab, and Perim for Messrs. Pirelli & Co., of Milan, who are acting under contract with the Italian Government, are composed of the following types:—Conductor, a strand of seven copper wires of 0·031 inches; core, three coats of gutta-percha, the completed core having a diameter of 0·28 inches, and being covered with a bedding of jute. *Deep Sea Type.*—Sheathing, 10 iron wires, each having a diameter of 0·22 inches, and each wire covered with compounded tape. The completed cable has a diameter of 1·06 inches and weighs 3·6 tons per N.M. *Intermediate Type.*—Inner serving a hemp tape, followed by a metal tape, then a compounded hemp tape, the sheathing wires being 10 in number, each wire having a diameter of 0·295 inches. The completed cable has a diameter of 1·37 inches, and weighs 7·2 tons per N.M. *Shore End.*—The same as the intermediate, excepting that the 10 sheathing wires are each of 0·37 inches diameter. The completed cable has a diameter of 1·88 inches, and weighs 12·25 tons per N.M. We are informed that the sections are composed as follows:—

Massowah-Assab.

Massowah shore end	3·0	N.M.
„ intermediate	5·0	„
Main cable	261·0	„
Assab intermediate	10·0	„
„ shore end	2·0	„
	281·0	N.M.

Assab-Perim.

Assab shore end	2·0	N.M.
„ intermediate	10·0	„
Main cable	40·0	„
Perim intermediate	2·0	„
	54·0	N.M.

A New Insulating Process.—The following method of insulating electric light conductors has been devised by Messrs. Weber and Schefbauer. Two or more copper conductors are placed parallel to one another at a convenient distance, and are covered with several layers of paper tapes which have been passed through a bath of ammoniacal oxide of copper. The paper covering thus obtains an outer coating of cellulose, and by passing the core through rollers of the proper shape, the cellulose on one spiral combines with the neighbouring spirals, forming a solid mass. During the passage through the rollers the conductors are carefully guided, so that they cannot come into contact. The core is again passed through the bath, the cellulose, to a certain depth, being thus detached, and it is then taken through rollers heated by steam and exercising considerable pressure; the core comes out dry, and with a smooth surface. A third bath in boiling linseed oil is given, the core being heated so as to allow the paper to thoroughly absorb the oil; finally the rollers are again employed so as to expel any excess of oil. It is claimed that conductors thus treated form a pliable and elastic cable, and that the presence of moisture is rendered impossible.

Purifying Water by Electricity.—Prof. Hugo Blanck, of Pittsburg, Pa., says that the passing of an electric current through water kills all the germs of disease that are in it. Experiments, it is stated, have been made with water taken from the Monongahela river, near the sewer escapes, with entirely satisfactory results. A Pittsburg capitalist has built large tanks in that city from which he proposes to supply citizens with water made pure by the electrical process.

The Brussels Exhibition Fountains.—The illuminated fountains to be used at the Brussels Exhibition will be of a different character from those used in London and Manchester. Only one very powerful arc lamp will be used, and special effects obtained by the differential rotation of two coloured glass discs. The rays will strike a mass of pulverised water produced by revolving nozzles, and by this means a more brilliant effect is expected with only half the power which would otherwise be required.

Glass-cutting by Electricity.—The cutting of glass tubes of wide diameter is another of the almost innumerable industrial applications of electricity. The tube is surrounded with fine wire, and the extremities of the latter are put in communication with a source of electricity, and it is of course necessary that the wire adhere closely to the glass. When a current is passed through the wire, the latter becomes red hot and heats the glass beneath it, and a single drop of water deposited on the heated place will cause a clean breakage of the glass at that point. Contrary to what takes place with the usual processes in the treatment of this frangible material, it is found that the thicker the sides of the tube are the better the experiment succeeds.

New Journal.—In the *Journal of the City and Guilds of London Institute, Finsbury Technical College, and Old Students' Association* we have a combination of the two independent journals formerly, for a short time, issued by the students of the Finsbury Technical College and the Old Students' Association. In the new form it is proposed that the *Journal* shall not remain exclusively technical, but shall discuss art and general topics, so as to enlist the sympathy and interest of the students at the South London School of Art, which is connected with the same main organisation. A good beginning is made, and we wish the new venture every success.

Removals.—Messrs. H. Lazarus & Co. have removed from 36, Basinghall Street to more extensive premises at 10, Manchester Avenue, Aldersgate Street.

Messrs. B. and G. Shorthouse have removed their London offices to Mansion House Chambers, 11, Queen Victoria Street, E.C. (Messrs. Applegarth and Stove, agents).

Fire at Lord Brassey's.—On Wednesday night last week, an outbreak of fire occurred at the residence of Lord Brassey, K.C.B., 24, Park Lane. One of the servants discovered the fire in the back basement, and instantly raised an alarm. The other servants assembled, and buckets of water were immediately requisitioned, with the result that the flames were completely subdued before the arrival of the firemen. "It was then found that the fire had occurred amongst the wooden fittings of an electric light converter which had been set on fire by a spark from the converter."

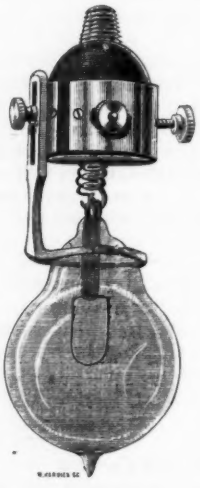
The Right of Way for Underground Cables.—An interesting question has been raised at St. Etienne, says *Industries*, which is of importance in connection with the establishment of central stations for electric lighting. The municipality of the town having given a concession to a company to lay cables in the streets, the local gas company brought an action in the prefectural court to prevent this arrangement being carried out, on the plea that it was an infringement of their monopoly for laying down conduits. The Court has decided that the monopoly granted was only for gas lighting, and that the town could not bind itself to grant sole rights to use the streets for purposes which at the time were unheard of. The attempt, therefore, of the gas company to suppress the electric lighting in this town has consequently failed.

The Kapp Dynamo.—A correspondent writes:—"Referring to your note last week *re* Silvey and Kapp, Piracy, &c., a very curious case in point occurred some time back, which being anterior deserves notice, as it is also a Kappital case. In 'Traité Pratique d'Electricite,' by C. M. Gariel. Tome Second, Paris, 1886, you will find at page 182, fig. 371, 'Machine Gramme, type superieur,' with the Gramme Company's name on it. That is as much like a Kapp as you usually see, but if the dates are correct as given to me, the phrasing should be that the Kapp is very like the form of the Gramme Company, which is the first in the field of the topsey-turvey Edison type! So who can claim what is termed the Kapp form?"

Institution of Engineers and Shipbuilders.—At the meeting of the Institution of Engineers and Shipbuilders of Scotland, held last week in Glasgow, an interesting paper was read by Mr. F. J. Rowan, C.E., on "The Applications of Electricity to Portable Engineering Tools."

Obituary.—We regret to hear of the death in Dublin, on Tuesday, of Mr. Edward Dwyer Gray, M.P., Chairman of the Telephone Company of Ireland, and a director of the United Telephone Company.

New Lampholder.—The accompanying sketch represents a neat form of adjustable lampholder designed by Mr. Theophilus Coad. The metal portion is nickel-plated and the *tout ensemble* is elegant. By turning



the screw head shown on the right of the figure in one direction or the other, the lamp is either put in or cut out of circuit. A reflector, not shown in the drawing, is employed in combination with the adjustable support. There should be a demand for this ingenious holder.

The Bankruptcy of Mr. Volk.—At Brighton Bankruptcy Court last week the judge heard an appeal by Mrs. Julia Hamilton, of 16, Lewis Crescent, against the rejection by the Official Receiver of a proof for £1,500 *in re* Magnus Volt, proprietor of the Brighton Electric Railway. Mr. Rutherford, who appeared for the appellant, stated that the sum in question was advanced to the debtor at the time the railway was in course of construction. He produced an agreement in which his client agreed to purchase 150 shares in the railway at £10 per share. The value of the railway was set down at £10,000, and therefore he submitted that her share would be three-twentieths of the whole concern. Mr. Benson Clough appeared for the debtor, and on the question arising as to whether the appellant was not really a partner in the concern, said that he would not admit that such was the case. Mr. Rutherford remarked that he did not want any such admission, and read a letter from his client requesting Mr. Volk to repay £500 at a certain date in accordance with the terms of his agreement. His client was a lady of very large means, and did not wish to harass the small creditors, provided that a reasonable offer was made. His Honour said that he was unable to interfere in that. Mr. Muir Mackenzie, for the Official Receiver, having stated that he could not admit proprietary right, the matter was eventually adjourned until April 13th.

Lectures.—In the theatre of the Dublin Royal Society House last week, the Rev. Gerald Molloy, D.D., D.Sc., delivered two lectures on electric lighting, the first on "How the electricity is produced," and the second on "How the electricity is converted into light." He had a large and appreciative audience upon each occasion.

NEW COMPANY REGISTERED.

Petroleum Engine Company, Limited. — Capital: £100,000 in £5 shares. Objects: To carry into effect an agreement of 27th inst. for acquiring the undertaking and assets of the Petroleum Engine Company, Limited, and also an agreement of the same date entered into with Albert Douglas Moll. To carry on the business of mechanical and chemical engineers and of workers and dealers in electricity, motive power, and light, and any business in which the application of electricity or any other power is or may be useful. To deal in electrical generators or accumulators, electro-motive, oil, gas, water, steam, or other engines, and all or any kind of electrical and other apparatus and appliances. Signatories (with 1 share each): T. T. Curtis, 17, Triangle, Old Kent Road; W. Micklethwait, 34, Millman Street, Bedford Row; G. F. Adams, 152, Fairbridge Road, Upper Holloway; S. Denton, 128, Lancaster Road, Notting Hill; J. R. Smith, 17, Lowfield Road, West Hampstead; Arthur Betts, Blurton Road, Clapton Park; C. M. Taylor, 31, Queen's Road, Upton. The first directors are Messrs. Jarvis Wm. Barber, Hy. Pawson, C. B. Bright McLaren, and Ernest Moreton. Qualification: 50 shares. Remuneration: £100 per annum for each director. Registered 26th inst. by Messrs. Maddisons, 20, King's Arms Yard.

OFFICIAL RETURNS OF ELECTRICAL COMPANIES.

Swan United Electric Light Company, Limited.—The annual return of this company, made up the 13th inst., was filed on the 23rd inst. The nominal capital is £1,000,000 in 200,000 shares of £5 each. There have been taken up 78,949 ordinary shares upon which £3 10s. per share has been called, and 19,750 fully paid shares. The calls paid amount to £279,851 10s. The sum of £3,530 has been paid upon 1,201 shares forfeited.

Brighton Electric Light Company, Limited.—The annual return of this company, made up to the 3rd inst., was filed on the 21st inst. The nominal capital is £25,000 in £5 shares. 1,883 shares have been allotted, and the full amount has been called and paid thereon.

Anglo-Portuguese Telephone Company, Limited.—At an extraordinary general meeting of this company, held at the offices, No. 53, New Broad Street, on 24th ult., the following resolution was passed and was confirmed at a meeting held at the same place on the 14th inst., viz.:—"Resolved: That article 105 of the articles of association be rescinded and the following article substituted in its place." "A managing director shall be summoned to be present, and to vote at all meetings of the Lisbon board, but without power to participate in the remuneration provided by Clause 91, and he shall not, while he continues to hold that office, be subject to retire pursuant to the foregoing provisions, but if he shall, at the time of his appointment, be a director, then (subject to the provisions of any contract between him and the company) he shall be subject to the same provisions as to resignation and removal as the other directors of the company, and if he ceases to hold the office of director from any cause he shall *ipso facto* and immediately cease to be a managing director." This special resolution was duly filed on the 21st inst.

House to House Electric Supply Company, Limited.—An agreement, dated 20th ult., filed on the 23rd inst., between this company and Robert Hammond, of 117, Bishopsgate Street, cites that the latter has for some time past successfully carried on at Brighton and Eastbourne a system of electric lighting, and is entitled, with others, to the benefit of a provisional specification in respect of a patent for a meter of electric currents.

Mr. Hammond has paid, or is liable to pay, all expenses in connection with the formation of the company up to the 13th January last, and has expressed his willingness to become managing director. It is therefore agreed that Mr. Hammond shall be managing director for two years, and will give to the company, its officers and directors, all the information in his possession relative to the system of electric lighting now in use in Brighton and Eastbourne, and will assist in establishing in London and elsewhere a similar system or otherwise, the company to receive from him a license to use the said meter for the term of the said patents when acquired, at a royalty at the rate of 20s. per electrical horse-power of 746 watts. As consideration the company will pay to Mr. Hammond £5,000 cash, and will allot, as he may direct, 100 fully paid founders' shares and 1,000 fully paid ordinary shares of £5 each.

An agreement of 25th ult., filed on the 23rd inst., between this company and Robert Hammond, is supplemental to the agreement of 20th ult. The document states that it has been mutually agreed that the consideration payable to Robert Hammond shall be reduced in the following manner :—The said principal indenture shall be construed as if the words £2,000 cash had been originally inserted therein in lieu of £5,000 cash.

Julien Electric Company, Limited.—An agreement of 23rd inst., filed on the same day, provides for the purchase of the patent rights of Edmund Julien, of Brussels, for 7,000 fully-paid shares of £10 each.

Petroleum Engine Company, Limited (formerly the Self-Propelling Motor Syndicate, Limited—Etéve's motor).—The annual return of this company, made up to the 5th January, was filed on the 16th January. The nominal capital is £25,000 in £5 shares. 4,814 shares have been allotted and the full amount has been called thereon. The calls paid amount to £10,368 10s., and unpaid to £512 10s. The sum of £13,200 is considered as paid upon 2,640 shares. Upon 18 shares forfeited the sum of £11 has been paid. One share warrant representing £7,075 is outstanding. The total amount of share warrants, comprising 178 shares surrendered since the last summary, is £890.

National Telephone Company, Limited.—The registered office of this company is now situate at 162A, Queen Victoria Street.

Electric Apparatus Company, Limited.—The registered office of this company is now situate at 4, Charing Cross, S.W.

CITY NOTES, REPORTS, MEETINGS, &c.

Direct Spanish Telegraph Company, Limited.

THE half-yearly meeting of this company was held at Winchester House, Old Broad Street, on Monday, under the presidency of Sir Jas. Anderson.

Mr. Ch. Gerhardi, secretary, having read the notice convening the meeting, and the minutes of the previous meeting having been read and confirmed,

The Chairman, in moving the adoption of the report, said he had very little to add to what was stated in that document. The revenue had increased by £1,338, notwithstanding the fact that the traffic on the Barcelona section had fallen off owing to the absence of speculation; therefore, this increase of traffic was nearly all due to other parts of Spain. He might add that for the first three months of the present year there was a still further increase in the receipts, amounting to about £250; this included an estimate of what the Easter week traffic, which was always small, was likely to produce. He hoped that next year, as a result of this increase, they would be able to pay 5 per cent. dividend on the ordinary shares. It only required £600 to pay 1 per cent., and he saw no reason why they should not reach the figure he had stated, and perhaps higher, because the trade of Spain had evidently taken a start. It required no less than 181,000 words to cause that increase of £1,300. The decrease on the Barcelona section amounted to 10 per cent. What pleased him more than anything else was the statement in the last paragraph of the report that the sum of £8,447 had now been placed to the reserve fund. He told them at the last meeting that they were getting a direct wire from Madrid to Bilbao. That line was not yet finished; when it was he hoped the traffic would be still further improved, because nothing more increased telegraphic communication than rapidity of transmission and accuracy. The average time now occupied in telegraphing between Bilbao and London was five minutes, leaving nothing, he thought, to be desired; but if they could get a special wire through to Madrid they might reduce the time between London and Madrid to 5 or 7 minutes. The company was prosperous. They were working at a very low tariff, and their revenue was increasing. Altogether, he thought the position was very satisfactory, and the Direct Spanish would compare with any telegraph company in London. He moved that the report and accounts be received and adopted.

Mr. Edmund Etlinger seconded the motion.

Mr. Dyett referred to the matter of unclaimed dividends, and questioned the manner in which they were dealt with in the accounts.

Mr. Newton having also spoken on details of account,

The Chairman in reply said they did all they could to make known the fact that there were unclaimed dividends. The additions to reserve were made under the agreement, and they were bound to make them. The debentures of the company were terminable, and would expire in 1894. It had occurred to him that they might as well call up the unpaid capital and pay themselves the 6 per cent., but that was a matter as yet of the future, and did not press at all.

The motion was unanimously agreed to.

The Chairman then moved that dividends at the rate of 10 per cent. on the preference shares and 2¾ per cent. (free of income-tax) for the half year on the ordinary shares, making, with previous distributions, 4 per cent. for the year, be declared. This also was carried unanimously, the retiring directors, Sir Jas. Anderson and Mr. Etlinger, and the auditor, Mr. Herbert R. Duke, were re-elected, and the meeting terminated with a vote of thanks to the chairman.

Daniel Judson & Son, Limited.

THE third ordinary general meeting of this company was held at the Masons' Hall Tavern, Coleman Street, on Friday last, Mr. E. E. Harding in the chair.

The Chairman, in moving the adoption of the report, said the balance-sheet for the past year was unsatisfactory, but he did not think the affairs of the company were so bad as they appeared on paper.

Mr. Judson, the managing director, in a statement explaining the causes which had led to the ill-success of the company latterly, attributed the losses mainly to the American and general business, and made the following remarks in reference to the electrical portion of the business :—As regards the electrical and carbon works, the directors believe this will ultimately be a successful and remunerative branch of the business. Here, again, we have dispensed with the services of an expensive manager, and by means of economies and reductions all round I am pleased to say that from a rough statement I have just had prepared there is a small profit made this year, which I hope to materially increase. With regard to the "Automatic" electrical machine, we have joined a combination for the construction and introduction of all kinds of automatic machines, called the Universal Automatic Machines Company, Limited, which now owns between 30 and 40 British patents, besides a number of foreign patents. A large number of machines will soon be placed, and the results from the few already fixed are most satisfactory.

Mr. Pink, formerly a director, said with regard to the electrical business, though it had made a loss, he had as much confidence in the future for it as ever he had. The patents for the galvanic batteries were successful, and he had them working in his own house for months without attention. He thought there was a future for the company, and he held more shares than when he resigned.

The report was adopted, and the shareholders nominated Mr. Sisterton to a seat on the board to represent their interests.

The Direct United States Cable Company, Limited.—The directors have resolved upon the payment of an interim dividend of 2s. per share, free of income tax, being at the rate of 2 per cent. per annum for the quarter ending March 31st, 1888, such dividend to be payable on and after the 24th April next.

Maxim-Weston Electric Company, Limited.—The ordinary general meeting of this company was held on Wednesday at the Cannon Street Hotel, when the directors' report and accounts were adopted.

Schanschieff Electric Light and Power Company, Limited.—The shares of this company were dealt in on Monday at ½ to ⅝ premium.

TRAFFIC RECEIPTS.

The Western and Brazilian Telegraph Company, Limited. The receipts for the week ending March 23rd, 1888, after deducting the fifth of the gross receipts payable to the London Platino-Brazilian Telegraph Company, Limited, were £4,179.

The Brazilian Submarine Telegraph Company, Limited. The traffic receipts for the week ending March 23rd amounted to £5,094.

PROCEEDINGS OF SOCIETIES.

The Society of Telegraph-Engineers and Electricians.

AN ordinary general meeting of this society was held on Thursday, March 22nd, Mr. E. GRAVES, President, in the Chair.

The minutes of the last ordinary general meeting having been read and confirmed, and the list of new and proposed new members announced, a lecture was given by Prof. A. W. Rücker, F.R.S., on "Electrical Stress." The lecturer stated that some years ago Dr. Kerr had given the results of experiments which he had made on electrical stress, experiments which had subsequently been repeated by Mr. J. E. H. Gordon. These experiments did not, however, appear to have been generally made known, though they were of great interest and very instructive. The lecturer then gave a series of experiments showing the effect of electrical stress on a medium through which a beam of polarised light was passed. The media were placed between two metal plates, the latter being electrified to a high potential by a Wimshurst machine. When a beam of light was passed through the medium parallel to the two plates, a Nichol's prism being in the path of the beam, no light passed, but immediately the plates were electrified the polarisation plane of the medium became rotated and the light passed. The intensity of the effects were dependent upon the potential value of the electrical charge causing the stress.

At the conclusion of the lecture,

Prof. CAREY FOSTER, being called upon by the President, expressed his extreme admiration of the beautiful way in which Prof. Rücker and Mr. Boys had brought the result of their investigations before the society. The lecture was most instructive, and had an important bearing upon the existence and general theory of crystals.

Prof. ADAMS was very glad to add a word to what Prof. Foster had said. They who were acquainted with these subjects knew the very great difficulties in the way of presenting the matter to an audience, difficulties which could not be too strongly dwelt upon. The experiments they had seen that night were exceedingly beautiful, and they were also exceedingly difficult. But Prof. Rücker and Mr. Boys had overcome the difficulties exceedingly well. If there were not the facility for representing these experiments upon the screen, the audience would have to take the essential facts on the faith of the lecturer, or would be under the necessity of going through a great deal of difficult mathematics. Here they had seen for themselves that which was not only very beautiful but most valuable, from a scientific point of view.

Prof. PERRY said he would ask a question to clear up a difficulty which might have occurred in the minds of some of the young members, and, if he were himself under a wrong impression, in order that he might be corrected. At the beginning of the experiments reference was made to the charge on two plates which had air only between them. A plate of paraffin was inserted, and they saw that the condenser had then a greater capacity of action, the electrometer deflection being increased. Then it was shown that there was no liquid, no water, on the surface of the paraffin. A plate of tin was placed over it, and he thought Prof. Rücker might have led them astray in saying that after putting in this plate of tin, or paraffin covered with tin, the deflection was pretty much the same as it was at first. As a matter of course, putting in the tin made the whole plate of an infinite specific inductive capacity.

Mr. GORDON said the experiments illustrated the theories of Clerk-Maxwell, and proceeded to detail the instances wherein the assumptions of that scientist had been justified.

Prof. AYRTON complimented Prof. Rücker and Mr. Boys on the extreme beauty of the experiments that they had shown, and pointed out how valuable were such optical illustrations of the stress in dielectric to those who, like himself, had to teach the theory of the action of strained dielectrics. He would like, however, to know whether Prof. Rücker could inform them why the effect of polarised light on glass under electric induction was so extremely small, for he understood from Dr. Lodge that the mere *electrostatic attraction* of the charged coatings of a glass Leyden jar was able to produce the entire effects shown by polarised light. That there was real electrical stress in the dielectric was certain in the case of the bisulphide of carbon, as, of course, a fluid would yield under the electrostatic attraction of the charged metallic coatings. Why, then, did the glass of an electrified Leyden jar show so little effect? Prof. Ayrton also mentioned that he did not consider that the experiment which they had seen of putting a metallic coating on the slab of paraffin wax disposed of the possibility of the action being due to a very fine coating of moisture spread over the surface of the wax in such a way as to make the surface slightly conducting.

Prof. SILVANUS THOMPSON said they were very fortunate in being Britons, for whoever had any acquaintance with Continental textbooks knew that in them all the important part of the subject was carefully left out. In very few was anything said about the medium, whilst they were told all about the conductors. Nearly all the great mathematicians, who took the laws of inverse squares for electrical action, calculated everything upon the theory that there was an action at a distance. Faraday had done much to release them from that idea, and now they saw that he was right. In speaking of Clerk-Maxwell, Mr. Gordon had caused his (the speaker's) recollection to travel back to a little book by F. C. Webb on "Electric Induction," which had afforded him a great deal of instruction in times past. This book contained some excellent diagrams showing what ought to happen in electric fields of different kinds. If some of those diagrams could be made up and shown on the screen they would convey a very clear picture of what took place in the electric field. Faraday's speculation was as to what they ought to see if they had not only an electric but a magnetic light. Sir George Grove had also done a great deal to elucidate this point by his experiment with a tube containing dilute mud made with precipitated oxide of iron, by which it was shown that more light came along the lines of magnetic force than passed when the tube remained unmagnetised. That experiment deserved to be better known.

Prof. Rücker, replying to Prof. Perry's remarks about the experiment with paraffin, said he did not mean to be taken quite literally. In answer to Prof. Ayrton, he said it might possibly be assumed that moisture had something to do with electrical action if it were the case that the electricity spread over the paraffin with the same ease that it spread over the metal; but the paraffin, as a matter of fact, was not so readily charged as the metal. With regard to the other point raised, the cause of the behaviour of glass under the influence of electric induction, he might say that he had not been able to repeat the experiment of Dr. Lodge. It was to be hoped more light would be thrown upon this subject. He believed Prof. Thompson would be the first to admit that Quincke was an illustrious exception to the accusation he had brought against foreign mathematicians.

Mr. BOYS pointed out that the suggestion put forward by Prof. Ayrton regarding the electrostatic attraction of the charged coatings of a Leyden jar might explain why no marked optical effect was produced with glass. For it was possible that the electrical stress on the glass itself tended to produce an expansion of the glass along the lines of induction which was resisted by the electrostatic attraction of the charged coatings, so that with glass, as Prof. Ayrton had remarked, the effect produced on polarised light might be merely a residual one.

The meeting then adjourned.

NEW PATENTS—1888.

4119. "Electrical appliances for curative and strengthening purposes." H. C. B. SHALDERS, A. J. THORMAN. Dated March 17.

4153. "Improvements in means for regulating or controlling the secondary current derived from continuous electric current transformers." F. KING. Dated March 17.

4177. "Improvements connected with insulators for the purpose of regulating the tension of telegraph and telephone line wires." E. BAINES. Dated March 19.

4208. "Improvements in apparatus for opening doors by pneumatic or electrical energy." C. W. F. THODE. Dated March 19.

4222. "A regulating appliance for dynamo-electric machines worked by gas motor or other engines." H. P. HOLT. Dated March 19.

4240. "Improved apparatus for the making and breaking of contact in electrical appliances, especially applicable for burglar alarms, and instead of pushes for ringing electric bells." H. B. YARDLEY. Dated March 20.

4270. "Improvements in the method of and apparatus for controlling or regulating the movement of electro-dynamic motors, or of machinery or apparatus propelled or driven thereby." B. A. FISKE. Dated March 20.

4274. "Improvements in or relating to storage batteries." W. P. THOMPSON. (Communicated by C. D. P. Gibson, United States.) Dated March 20. (*Complete.*)

4275. "Improvements in or relating to storage batteries." W. P. THOMPSON. (Communicated by C. D. P. Gibson, United States.) Dated March 20. (*Complete.*)

4277. "Improvements in electro-mechanical movements." A. J. BOULT. (Communicated by J. F. McLaughlin, United States.) Dated March 20. (*Complete.*)

4280. "Improvements in the method and means for increasing the frictional contact between the wheels and rails in railways." A. J. BOULT. (Communicated by E. E. Ries and A. H. Henderson, United States.) Dated March 20. (*Complete.*)

4292. "An improved switch and fuse for electric light and other purposes." C. E. G. GILBERT. Dated March 20.

4317. "An electric lamp and bell, and improvements in electric lamps." J. J. MASON. Dated March 21.

4330. "An improvement in dynamometers." P. FUESS. Dated March 21.

4345. "Improvements in the method of and apparatus for distributing electrical energy by alternating currents from central stations." G. KAPP. Dated March 21.

4353. "Improvements in electric telegraph insulators, and in the manufacture thereof." E. W. BULLER. Dated March 21.

4393. "Improvements in and relating to the control of electric currents." W. S. FREEMAN. Dated March 22.

4425. "Improvements in dynamo-electric machines or motors." P. J. CHARLES, L. HANSON, and R. H. FOWLER. Dated March 22.

ABSTRACTS OF PUBLISHED SPECIFICATIONS, 1887.

114. "An improvement in dynamo-electric and electro-dynamic machines." W. A. LEIPNER. Dated January 4. 8d. Claim:—A revolving armature for a dynamo-electric or electro-dynamic machine, consisting of a non-magnetic nave having in its periphery equidistant notches, each wider at the bottom than at its mouth, in each notch a composite spoke consisting of numerous iron plates rivetted together, and presenting indentations on its sides, and between the spokes bobbins of insulated wire coiled on composite cores, which are made up of numerous iron plates and are so shaped that their ends fit into the indentations of the spokes, the bobbin spokes being retained laterally by rings and brackets fixed on the sides of the nave.

205. "Improvements in electrical communicating apparatus applicable for use in navigable vessels." W. CHADBURN. Dated January 6. 1s. 3d. According to this invention the inventor uses a transmitting instrument upon which a number or series of contact-making pieces are arranged, over which a contact-maker or a number of contact-makers may be moved to make and break contact, and a receiving instrument which is in electrical communication with the transmitter. One or both (as the case may require) of the instruments are provided with a series of electric lamps, and one lamp (having suitable connections) is provided for each order, condition, or position in or upon the instruments. The lamps are arranged in a suitable case or cases (to which access can be readily had), and are caused to illuminate words, letters, or figures, representing the order, condition, or position sent. This may be effected by the light of each lamp being reflected upon the word, letters, or figures of the order or condition with which it is connected. Or it may be effected by the light being transmitted through apertures or a translucent dial or dials containing the words, letters, or figures upon its or their face or faces; or the words, letters, or figures may be delineated upon the lamps, or may be otherwise suitably placed. The claims are 7 in number.

254. "Improvements in electrical communicating apparatus, partly applicable to pneumatic and other like communicating apparatus." W. CHADBURN. Dated January 7. 8d. According to this invention there are employed a transmitting and receiving instrument. In the transmitting instrument there is a suitable contact-making device, and in the receiving instrument there is provided an incandescent electric lamp or lamps. The two instruments are connected by suitable communicating wires, and electricity is supplied from any suitable source. The apparatus is so arranged and connected that when contact is made at the transmitting instrument, a current of electricity will flow through the connections and lamps, which will thereby be made to glow or become incandescent. The light thus made is utilised to illuminate words, letters, or figures indicative of orders, conditions, and like communications. The claims are 5 in number.

395. "Improvements in induction coils or transformers." O. ZIPERNOWSKI, M. DERI, and O. T. BLATHY. Dated January 10. 8d. Claims:—1. In induction coils or transformers having a circular or oval or polygonal iron core closed upon itself, the construction of the iron core out of a suitable number of rings or discs obtained by the spirally coiling upon itself of narrow and very thin iron ribbon, substantially as set forth and described with reference to the drawings. 2. The construction of induction coils or transformers, as described with reference to the drawings, wherein a coil of the inducing and induced wires is surrounded with iron sheet, constructed and arranged in such a manner as to facilitate the winding of the conductors, substantially as set forth.

493. "Improvements in multiplex telephony." A. R. BENNETT. Dated January 12. 8d. Consists of a method of transmitting several telephonic messages simultaneously and independently over a single pair of conductors. There being two telephone stations, A and B, several miles apart, two wires or conductors are erected between them, Y and Z, which two wires owing to the transfer of speed by induction, cannot be used as two independent conductors in the usual way. At each station there is joined in the circuit of each wire a resistance, which may conveniently consist of a bobbin of wire. After passing through their respective resistances the wires, Y and Z, are joined together at their extremities. At this stage, the two wires, Y and Z, form a metallic circuit, each side or half of the circuit passing through two resistances, one resistance at station A, the other at station B. A set of telephonic instruments are then joined at each station so as to form a bridge between the two sides of the metallic circuit, the said bridge being made between the resistances and the wires going away to the other station. At this stage, conversation may be carried on between the stations A and B, by means of these instruments. From the points at which the two wires are joined together to form the metallic loop, two branches are taken, one at station A, the other at station B, to the earth, and in each of the two earth wires so formed, another set of telephonic instruments is inserted. There are now two sets of instruments at station A, and two sets at station B, one set at each station forming a bridge between the two sides of the metallic loop on the line side of the resistances, and the second set at each station being joined in the earth wire, on the earth side of the resistances. The two resistances employed at station A, should be of exactly equal value, and the two resistances at station B, should be of exactly equal value. The two wires joining the stations, A and B, should be as nearly of the same resistance and insulation as possible. There is 1 claim.

564. "An improved electric motor." H. H. LEIGH. Dated January 13. 8d. Claim:—An electric motor utilising alternative currents in the magnets and ring armature, both wound with two insulated iron wires, and having two commutators upon the armature, said motor being adapted to be self-starting and to avoid the usual drawbacks incidental to the use of alternating currents.

565. "An improved electric transformator." H. H. LEIGH. Dated January 13. 8d. Claims: 1. The described construction of transformator, having a long core of plaited or woven iron wire, or a tube upon which two parallel wires are wound. 2. The use of transformators, constructed as described, in the distribution of electric currents varying within two limits. 3. The described method of governing by the use of a very sensitive solenoid index actuating by means of two powerful coils a cylinder adapted to roll upon two divisions, between which are the governing devices operating until the index regains a condition of equilibrium.

571. "An improved switch for telegraphic transmitting keys." R. M. CUNNINGHAM. (A communication from abroad by T. H. Davis and C. Peeling, both of Rio de Janeiro.) Dated January 13. 8d. Claims:—1. The combination with a telegraphic transmitting instrument such as described of the described double switch, consisting of the two contact segments carried by a rock shaft, and the corresponding contact springs and their connections with the different terminals of the instrument, arranged and operating, as and for the purpose specified. 2. In the described double switch for a telegraphic transmitter, the combination with the rock shaft carrying the contact segments of a spring for actuating it in one direction, and a handle for operating it in the other direction, the handle being arranged in relation to the transmitting keys, substantially as and for the purpose specified.

648. "Improvements in multiplex telephony." A. R. BENNETT. Dated January 15. 8d. Claims:—1. In telephonic apparatus of the kind described in the specification filed under the application for letters patent No. 493, of 1887, the employment of condensers in lieu of resistances, substantially as set forth. 2. In telephonic apparatus of the kind described in the specification filed under the application for letters patent No. 493, of 1887, the employment of condensers in conjunction with resistances in lieu of resistances merely, substantially as set forth.

3533. "Improvements in electric railway signalling apparatus." A. M. CLARK. (A communication from J. D. Gould, of America.) Dated March 8. 8d. Consists in an improved arrangement of circuits, relays, and signal magnets, whereby the danger signal is caused to be displayed when a train enters on the section to be protected by such signal, and is withdrawn when the line is clear. Further, it consists in a semaphore, operated by an electromagnet in the main line circuit, the semaphore arm having a coloured disc, and being enclosed in a glass casing as a protection against wind pressure, and as a snow and rain shield. The claims are 7 in number.

3749. "Improvements in electrical apparatus for the prevention of corrosion and formation of scale in steam boilers." M. KOTYRA. Dated March 11. 8d. The inventor employs in the interior of the boiler a rod or plate of iron, copper, or other suitable metal, which is partly covered by a coating of zinc or other metal of the same electrical properties. He attaches this to the boiler in any position which may be found most convenient, insulating the rod from the shell of the boiler. To this rod he attaches a wire connected up to an alternating apparatus worked in any convenient way from the engine; to which an electrical current from a battery or other electrical source is attached. Another wire is attached to the shell of the boiler, and is also affixed to the alternating apparatus. From the alternating apparatus two wires are conducted to the positive and negative poles of a battery or any other source of electricity. The claims are 2 in number.

3811. "A new method for obtaining electricity on vehicles." T. R. WESTON. Dated March 14. 8d. The means by which the electricity is obtained is by friction caused by using brushes or bars in the usual manner, and driven by the axle of the wheels, or attached to the wheel or wheels themselves, of a locomotive engine, train or any other vehicle driving a dynamo-electric machine, or to collect the current from a revolving armature, which is fixed preferably on the underside of an engine, train, or any other vehicle which consists in working an electro-magnet to rotate between the poles of a fixed electro-magnet, or coils of wire with or without any case, and reversing the current of the internal magnet at each point, when its lines correspond to the lines of the outside coils, the revolving magnet with its coils would form a disc, the current entering the coils of the rotating magnet are made to spend their inductive effect in increasing the magnetism of the outer coil, which greatly facilitates the efficiency of the motor. The claims are 3 in number.

4135A. "Improvements in electro-magnetic clock-time transmitters." H. J. HAIGHT. Dated March 18. 8d. Consists, first, in a new and improved means of transmitting by electro-magnetic power to one or more distant stations or localities the time indications of a standard or other clock, and of showing the same time on clock faces at the stations or localities, without requiring clockwork at the said stations or localities, and thereby avoiding the necessity of any winding of clocks or other attention thereto; second, in combination with the said clock-time transmitter of a comparer or verifier, located in the vicinity of the transmitting clock, whereby the correctness of the transmission of the time to the distant stations or localities is verified. The claims are 8 in number.

4303. "Improvements in and relating to secondary and other electric batteries." W. MAIN. Dated March 22. 8d. The inventor has discovered that it is not advantageous to separate the sheets of lead or lead foil from each other; but that they may much better be allowed to rest face to face, giving when so used an electrode of greater efficiency, relative to size, than any hitherto made. He finds that with this construction the electrolytic fluid will be drawn up between the plates by capillary attraction, in quantities amply sufficient to oxidise them, and yield maximum results as regards the storing of energy, it being only necessary to provide passage ways for the electrolytic fluid by means of holes or other channels passing through the plate from side to side at sufficiently frequent intervals. The claims are 11 in number.

5292. "Improvements in electric motors." H. J. ALLISON. Dated April 12. 8d. Consists chiefly in a particular form of journal bearing, which is adapted to operate for a long time without attention, in an improved construction for the armature and its commutator, and its connections between the field magnet and the brushes. It also consists in means for automatically detaching the brushes from the commutator when the brushes are placed in their inoperative position, in a particular form of bridge for uniting two inclined magnets, and in the combination with an arched bridge, of projections for sustaining the armature bearings, and in the combination with the arched bridge, of a bed-plate having a switch secured thereon beneath the arch so as to protect the switch from derangement. The claims are 10 in number.

5318. "Improvements in the art of utilising electric currents in connection with electric signalling apparatus or measuring instruments." J. E. WATSON. Dated April 12. 1s. 1d. The invention involves the method of using two voltaic currents in opposition to vary the magnetic attraction and means or apparatus whereby the method may be put in practical operation in effecting telegraphic or telephonic communication, or in other forms of electric signalling. The claims are 24 in number.

5462. "Improvements in dynamo-electric machines." W. H. SCOTT and E. A. PARIS. Dated April 14. 8d. Claim:—In dynamo electric machines the construction of armatures in which the conductor is wound between teeth or projections of great depth and in close proximity, substantially as and for the purposes specified.

7079. "The improvement of dynamo-electrical machines." E. WILSON. Dated May 14. 6d. Relates to a particular method of winding. The claims are 3 in number.

7975. "Improvements in secondary batteries or accumulators." L. C. E. LEBIEZ. Dated June 2. 4d. Claim:—The formation by electrolysis on the positive electrodes of secondary batteries or accumulators of a pulverulent coating of peroxide of manganese obtained by the use of an electrolyte or charging solution of any appropriate salt of that metal, substantially as herein set forth.

8076. "Improvements in holders for incandescent electric lamps." R. T. TURNBULL. Dated June 4. 8d. Claim:—The method of constructing the terminals of holders for electrical incandescent lamps by employing a guide tube to prevent the tendency to short circuiting which otherwise exists, substantially as described and illustrated by the drawings.

9104. "Improvements in dynamo-electric generators and motors." A. P. TROTTER, H. W. RAVENSHAW, and W. T. GOOLDEN. Dated June 27. 8d. Has for its object the providing of means whereby the electromotive force of the armature of a dynamo-electric generator may be modified, such modification being obtained by altering the useful, or inductive, effect of the field magnets without reducing their magnetic saturation to such an extent as would render their magnetism liable to become unstable. The invention consists in applying to a single horse shoe, or other suitable form of field magnet, a second or additional magnetic circuit, such as a similar horse shoe field magnet, which, when working under the conditions of a minimum electromotive force, would offer comparatively so much smaller a magnetic resistance than the armature and its air space, that nearly all the lines of force would be diverted through it. Though described as applied to a single horse shoe field magnet it will be understood that, similarly, to a multiple system of field magnets, one or more of the additional magnetic circuits may be applied. This second, or additional, magnetic circuit is provided with coils in the same way as the main magnet, and by passing a current through these coils the diversion of the magnetism of the main magnets may be obstructed until, with a certain strength of current, no lines of force would pass through the second, or additional magnetic circuit, and the electromotive force of the armature would then be produced solely by the whole useful magnetism of the main magnet, this condition corresponding to the normal electromotive force or output. The claims are 3 in number.

11356. "Improvement in electric couplings" C. RUNELS. Dated August 19. 8d. Relates to electric couplings or connectors especially adapted to connect separable sections of conductors in a closed circuit, and to enable said sections to be connected and disconnected without breaking the circuit, the principal use of said coupling being to unite the electrical conductors employed upon railway trains, to operate station indicators, or to signal from one car to another or to the engine, and from the engine to any one of the cars of the same train. The coupling is capable of connecting sectional conductors in open or closed circuits, and to unite the parts of sectional conductors of two or more circuits. Some of which are closed and some of which are open. The claims are 6 in number.

12636. "Improved means for discharging electricity from paper and other materials while being operated upon in printing and other machines." L. E. BATHRICK. Dated September 17. 8d. Claims:—1. In combination with a machine for operating upon sheets or strips of fibrous insulating material, a grounded fluid discharging-conductor arranged in the path of the sheets or strips, substantially as described. 2. In combination with a machine for operating upon sheets or strips of fibrous insulating material, a grounded fluid discharging-conductor held in a mass of fibrous material, and arranged in the path of the sheets or strips, substantially as described. 3. In a printing-press, the combination of the delivery apparatus thereof with fibrous material arranged in relation thereto, and a grounded fluid conductor held by said fibrous material in the path of the material operated upon, substantially as described. 4. In a printing-press, the combination with the delivery apparatus thereof, of fibrous material secured to the same, and a grounded fluid conductor held by said fibrous material in the path of the printed sheets or strips, substantially as described. 5. In an apparatus for delivering sheets or strips of insulating material after having received a charge of electricity, the combination of strips of fibrous material located in depressions below the surfaces of the apparatus, and in the paths of the sheets or strips, with a conducting-fluid held by the fibrous material, and ground-connections from the same, substantially as described.

13454. "Improvements in fittings for incandescent electric lamps." R. T. TURNBULL. Dated October 5. 6d. Claims:—1. Mounting the hooked spring terminals of an incandescent lamp fitting in such a manner as will allow of their being bodily removed from the fitting, in the manner substantially as described and illustrated. 2. The securing together of the parts of an incandescent lamp fitting by a flanged ring, which serves also as a shade, or globe carrier, and to carry the bow or other springs for steadying the lamp and putting the terminal springs in tension, substantially as described and illustrated.

CORRESPONDENCE.

Fire Office Rules.

However great the difference of opinion existing between electric light contractors and fire office inspectors, the advent of two more sets of rules, in addition to those of the Phœnix Fire Insurance Office, will not tend to simplify matters.

It is to everyone's interest to reduce electric lighting to its simplest form, an object which will certainly not be forwarded by having various authorities all looking at the subject from their own point of view. The stage to which matters have come has been more especially brought under my notice by my having been asked to draw up a set of fire office rules for one of the larger fire insurance offices. The effect upon the public mind will hardly be reassuring when they have to choose between conflicting opinions, every one of which is said by its upholder to be the one and only way of carrying out electric light installations. Whilst one does not wish an approach to the "go-as-you-please" license given to gas engineers, one does not wish to fall into the opposite extreme of having to take useless precautions. I had hoped that the days of firms putting in second-class materials and scamping their work were coming to an end, but the time for this seems likely to be still further prolonged if there are several standards of work, unless the Society of Telegraph-Engineers or the "Dynamicables" will take the matter up in a broad-spirited way. It would be as well to have a meeting of those interested, and for them to appoint a committee consisting of representatives of the fire offices, electrical societies, consulting engineers, electric lighting firms, &c., to draw up a set of rules. The present Phœnix Fire Insurance Office Rules might be taken as a basis, and altered or added to so as to include any points considered advisable by the committee. Finally, let this one set of rules be acknowledged, as it probably would be, by the fire offices, electrical societies, and profession generally, as the standard by which work must be carried out.

It might be of advantage to have a Committee of Appeal for new and disputed points in installation work, and there also might be a definite list of risks made out for different classes of buildings such as theatres, private houses, mills, &c., together with the class and description of insulation that would be passed

for such risks; this probably varying with the different systems of lighting and the rate at which the building is insured.

F. L. Rawson.

We in common with the author of the letter in your last issue (March 16th) on the above subject feel exceedingly alarmed at the prospect that opens out before us now that another set of rules have been published.

It would be difficult to arrange at the present stage of the industry any set of rules, the following out of which could better guard against dangers arising from electric lighting than those which have been drawn up by Mr. Musgrave Heaphy.

The writer has seen a number of installations, both on the Continent and in the United States with the result of feeling assured that work of this kind in England is infinitely superior to that carried out in other countries, and there can be no doubt that our comparative immunity from fire arises from the judicious enforcement of these.

A number of installations in this kingdom, including one or two of the largest, have been carried out by us, always under the Phœnix Fire Office rules, and in no single instance has an electrical fire occurred.

It must certainly be the experience of every contractor that there is no difficulty in obtaining the approbation of the authorities of installations conscientiously executed.

If we are to have several sets of rules it will be impossible to tender for work without a specification, and this means an expensive item added to the price of electrical work for the services of a consulting electrical engineer in each case, whose presence is unnecessary when a duly qualified fire inspector fills the position free of cost to the proposed user of the electric light.

We do think that this is a matter for the leading contracting firms to interest themselves in, and their verdict goes almost without saying.

To frame and impose rules it is necessary to have a "status." What is the "status" of those who are seeking to introduce the new ones, and what authority have they to handle a matter which so seriously affects the trade without first consulting it?

The matter is such a serious one that we trust more *direct and public impeachment* will quickly ensue.

Installers.

London, *March 22nd*, 1888.

Water Primary Battery.

Our client, Col. Malleson, C.S.I., has consulted us with reference to the article appearing in your issue Vol. XXII., No. 538, on the Water Primary Battery Company.

We must express our surprise that you should have commented in your journal in any way upon a prospectus which, according to your own admission, was a "private and confidential" document and not in any way issued to the general public. We regret you did not, at least, before writing as you did of our client and his co-directors, put yourself in communication with him, when you would have learnt the fact that our client's name only appeared in such private prospectus tentatively and subject to himself and his co-directors being satisfied as to the soundness of the concern.

In justice to our client and his colleagues, and considering the fact that the prospectus has not been issued to the public in any form, we must ask you to insert this letter.

W. H. Smith and Son.

London, *March 22nd*, 1888.

[We are pleased to insert the above communication, but at the same time our comments need no excuse in the eyes of our readers, nor do they occasion any surprise. If Messrs. Smith & Son's client desires further information on this topic, a reference to our back numbers will give him every facility for basing a judgment upon the soundness of the concern.—[EDS. ELEC. REV.]

The Taunton Electric Lighting Company.

I noticed in last week's REVIEW your leader on the Exeter Electric Light Company, and also the reference which you make to my not having responded to your invitation to explain the circumstances which led to so low a sum appearing against "salaries" in the annual report and balance sheet of the Taunton Electric Light Company. I have hitherto taken no notice of hostile criticism copied from the *Gas World* and other journals devoted to gas interests, but when I found these were being reproduced in the Exeter papers for the sole purpose of preventing the share capital of the Exeter Company from being taken up, I at once exposed the misleading statements made by the editor of that paper, and I have much pleasure in giving your readers also the explanation which you consider due from me. The statement of the above publication that £94 13s. 4d. was divided between five officers of the company, namely, the managing director, auditor, secretary, and two electricians, was as absurd as it was unjustifiable. To start with, the Taunton Company is practically a consumer's supply company, formed for the purpose of supplying the light at the lowest cost of production, and as the work of the directors is a labour of love, their remuneration is only nominal, and although I occupy the position of managing director, I am not, as *Gas World* supposes, a salaried officer of the company. Another individual designated an "officer of the company" is the auditor, who simply receives a small fee for his annual audits. A third is the secretary, whose duties are very light, and who receives the sum of £20 per annum. One of the two remaining "officers" draws his remuneration weekly, and it is consequently charged under the head of wages. The amount appearing in the balance sheet for the last year for salaries and wages is £327 17s. 10d., quite a sufficient sum for a small lighting company worked on a sound commercial basis. This year the expenditure will be relatively greater in proportion to the increased custom and capital employed. It is extremely gratifying to me that the only fault gas journals can find with the Taunton Company is that its costs of management are too small, and that had its officers been paid on an extravagant instead of economical scale, we should have been unable out of earnings to pay a dividend of 5 per cent., and carry forward a balance equal to an additional 2 per cent. upon the total share capital.

H. G. Massingham,
Managing Director, Taunton Electric Lighting Company, Limited.

March 24th, 1888.

Re Edison Tubes.

Regarding your note in the issue of March 16th on the failure of Edison tubes in the City of Milan. During the past four years the general working of the station has not been interrupted in any way from leakage of the tubes or other cause, and at the present time the underground conductors are in every way satisfactory. Some time ago it was found advisable to protect the *tubes* with wooden troughs and asphalte, owing to the leakage from sewers and the corrosive effect of the *débris* of old buildings. At that time the asphalting was applied, and since then no repairs have been made or found necessary.

Chas. A. Baker.

Milan, *March 23rd*, 1888.

Renewing Telegraph and Telephone Wires.

It is gratifying to know that my letter of 16th inst. afforded some amusement to Mr. Gilbert. The mirth it provoked would, I feel sure, be quite uproarious, but I have somewhere read (it may have been a proverb just a little differently worded) that "unwise," or let me say indiscreet," persons do become hilarious at their own want of wisdom," and this may fully account for

his indulgence. Your readers generally would smile, too, but will be more tickled now at the climbing-down process. From the high and mighty position first taken up Mr. Gilbert has dropped to that of a mere follower. He practically admits that the curving of the prongs suggested in his first letter was mistaken and unsuitable, and approves of the design furnished in my letter of 16th inst. with some microscopical alteration. It would be too much, of course, to expect him all at once to admit that curving of any kind is quite unnecessary, but practical people know that it is, and by-and-bye he also will acquire the information. I would just point out to him, however, that if the lines under his control are of peculiar construction, necessitating some kind of provision for "upward pull," he had better adopt another form of fixing for his renewing lever. "Upward pull" would lift the lever off the arm altogether and swing it like the screwless and cementless insulators of his wonderful imagination. Only a bare fortnight ago Mr. Gilbert declared that he "could not wish for a better or more practical device" than his renewing lever, and now we hear of a "favourite device," "on the roller principle," which has *for a long time* been occupying his attention. This does indicate some getting round, but it may be, Mr. Gilbert means by hook or by crook to lick creation. I don't know how the patentee of the runner will view the proposal, but it seems to me that a roller is simply a pulley elongated. The triple combination should be valuable, however, from a royalty point of view, and a big first cost does not seem to weigh much with Mr. Gilbert.

"When practicable" is the qualification now admitted in regard to carrying wire out on the drum. Yes, "when practicable," but experienced telegraph folks know that it isn't often practicable, and don't attempt it at all, because it is too laborious and expensive. It will die out in the Highlands, too, with advancing civilisation. Mr. Gilbert is evidently of opinion that insulators are screwed and cemented for the sole purpose of preventing wires from making off with the cups in their flight upward. This is an odd idea, and I wonder what telegraph engineers generally think of it. Surely he forgets the simple fact that wires are not bound to the insulators until viced up to their proper position. How, then, is it possible that cups can be lifted off the bolts, unless where poles are holding wires "*down*" instead of "*up*," as already jocularly suggested? If he does build lines like this, and he almost forces one to such a conclusion, the sooner he gets away from the new and back to the old, or general system of construction, the better.

Inspector.

Threepenny Telegrams in the United Kingdom.

Whereas there is a great deal of sound common sense in the assertion that to conduct wisely the business of the community, it is necessary there should be the completest means for diffusing information and circulating ideas, I understand that, as is rumoured, not few people are inclined to believe that some day, and not far distant, the sixpenny telegraph system will be turned into a threepenny one. As however the expenses of the service at present exceed the receipts, and a further reduction in the price for telegrams would most probably involve a new increase of expenditure, I fear the prospects of the schemers will have but little chance to find favour with the Post Office authorities. Nevertheless, I believe something could be done in order to meet the demands and, at the same time, secure due protection to the revenue, this consisting in lowering the rate—say with 50 per cent.—for those messages which can bear some delay in transmission. There can be no doubt that many senders would gladly avail themselves of such cheap telegrams, for there are several cases in which a message, to carry out its object, only needs to overtake the post, and plenty would be sent in preference to a letter or even a postcard. With regard to the latter allegation, I beg to repeat the words from a French author:

"Pourquoi . . . . la télégraphie ne ferait elle pas, dans certaines circonstances, une chose aussi simple que facile, c'est-à-dire spéculer sur la paresse et l'embarras que l'on éprouve généralement à écrire des lettres de souhaits de nouvel-an, de félicitations, fêtes, anniversaires, condoléances de pure forme, etc., qu'on ne peut éviter, et en faire une source de recettes pour le Trésor. Une lettre par trop courte risque d'être impolic et compromet ou la bonne volonté ou la facilité épistolaire de l'auteur; tandis qu'un télégramme, de sa nature, est essentiellement laconique. Il est totalement dispensé des formules prolixes de politesse, et affranchi des règles magistrales de la grammaire et des lois inflexibles de l'ortographe; la fantaisie abréviative y règne en souveraine et s'y permet souvent plus d'un heureux caprice?"

Let it no longer be said that a telegram not promptly despatched does not deserve the name of a telegraphic message, for there are a thousand and one events for which "deferred" telegrams, when cheap, would be used, not only amongst the wealthy, but also amongst the middle and lower classes. The threepenny telegram, even if delayed, will supply a want to business people which at present, on account of the sixpenny rate, they cannot afford themselves. It will, in a large way, create a traffic which did not exist before, and procure work during the hours that the many thousand miles of telegraph wires are idle now. Consequently it would prove a great boon to the public, *without entailing an increase of expenditure*, so that finally the measure would become, too, a financial success.

As for complications in the service of the offices, there should be no fear of that, as such do not occur in those Continental countries where the "two classes" system actually works. In these countries the system has been brought about by enhancing the rate for "preferred" or "first-class" messages, whilst conserving the old price for "second-class" telegrams. My suggestion, which aims at promoting the telegrams under present conditions to "first-class" messages by reducing the charges for the "deferred" ones, would be more liberal, but also cause an increase of business, in which direction a regulation such as mentioned in the first place, of course, must be of no effect. Whenever one of the Administrations which have brought the "two classes" system into operation feels inclined to enlarge the traffic, as hardly necessary to remark, recourse will have to be taken either to a decrease of the actual charge for the "second-class" messages or to the introduction of "third-class" telegrams at a cheaper price than that now charged for the "second-class" ones.

Linckens.

Catalogues.

As a further contribution to what has already been written on this subject, we would point out that the "catalogue of cables, leads, and insulated wires," issued this month by the Telegraph Manufacturing Company, Limited, of Helsby, contains exact copies of our price lists of April, 1887, the only variation being different pattern numbers and the omission of our name.

Those interested in the subject might compare pages 10, 11, 12, 13, 14 and 15 with our April (1887) price lists. Not only are our figures copied EXACTLY, but our phraseology, simply *seriatim et litteratim*. Probably other parts of the catalogue have been made up by equally flagrant copies from other makers' lists, if we may judge from pages 30 and 31, where Cheeseman's table and formula are given without acknowledgment.

Surely our Society of Telegraph Engineers and Electricians might extend its sphere of usefulness by adjudicating on questions of privilege and considering whether persons guilty of questionable practices are entitled to remain on their roll of members.

Walter T. Glover & Co.

March 26th, 1888.